Paul Pouvillon's Astronomical Clock
A Brief History and Description of the Clock's Restoration
By Mark Frank

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Chapter 1. A Brief History of Paul Pouvillon and his Astronomical Skeleton Clock

Some of the following historical information on Pouvillon is based on an article by Bernard Miclet.[1]

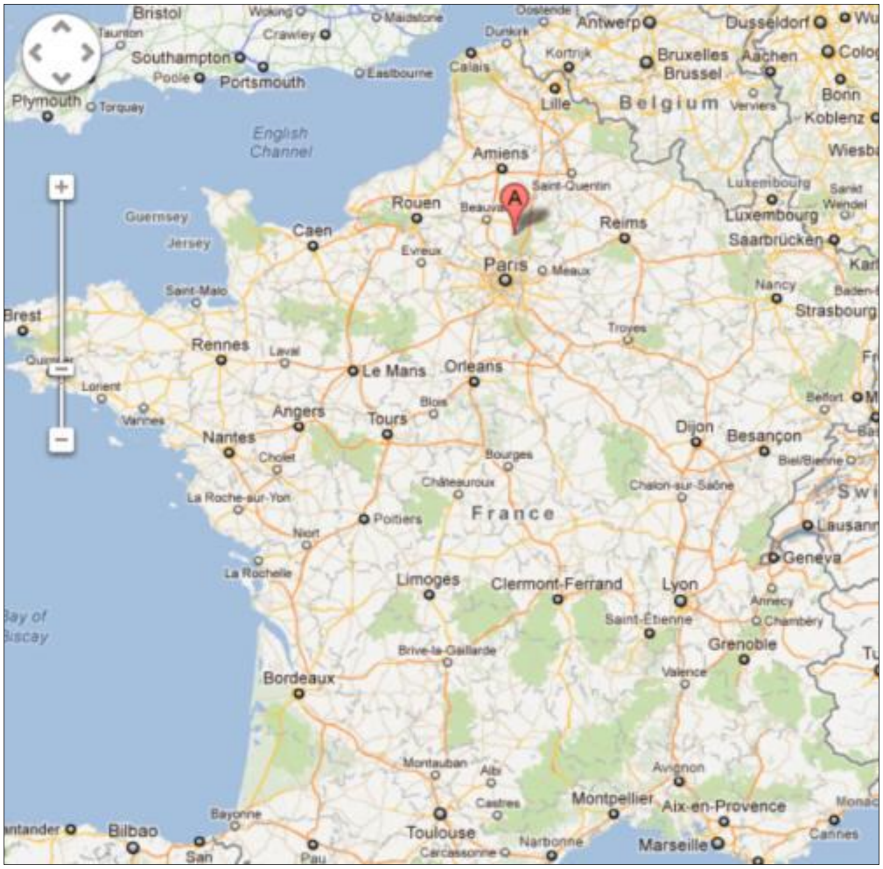


Figure 1. Map showing Pouvillon's home town of Nogent-sur-Oise

Paul Pouvillon was born in the small town of Nogent-sur-Oise, France about 20 miles (30km) north of Paris on January 24, 1878, (Figure 1). His father was a mechanic and his mother a seamstress and they ran their business from the store front beneath their apartment. At twelve years of age Pouvillon was apprenticed to a clockmaker to learn the trade. He excelled at this apprenticeship to such a degree that the master had waived his second year fee of 400 Francs. Soon afterward he went to work for several clockmakers and received high praise from each. In 1896, at a Besançon exhibition he obtained a bronze medal for his watch working. Two years later, he passed his professional examinations for "Ouvrier d'Art", *Master of the Art*. In recognition of his outstanding abilities the French government waived the normal three years of mandatory military service to one. He served this from 1899 to 1900. But instead of continuing his journeyman's training as was the custom, in 1902 he settled back in his home town and began his own practice at the age of twenty four. According to his business letterhead, (Figure 2), he was awarded another medal 1906 in Paris. The details of this award are unknown at this time. From 1929 through 1930 he undertook with another clockmaker from nearby Beauvais the repair of a complicated astronomical cathedral clock built by Auguste-Lucien Vérité from 1865 to 1868. During this job he began to formulate the idea of building his own astronomical clock. By the time of its completion, his astronomical clock brought Pouvillon accolades: first at Beauvais, where it was shown in 1939, and then in Paris, where it was awarded a silver medal. He was also awarded for this outstanding piece of work the coveted title of Meilleur Ouvrier de France, *Finest Worker in France*, and an award given every four years by the government in various areas of artisanship. Pouvillon was made a Knight of l'Ordre National du Travail, *Knight of the National Order of Labor*, in 1943 and received the Palmes Académiques, *Academic Palms* in 1947. He was made a Knight of the Légion d'Honneur, *Knight of the Legion of Honour* for his work, on August 9, 1948. At 75 years of age he was still adding some complications to this clock through at least 1953 and finished the final linkages for the Easter calculator at the age of 77.

Figure 2 is a calling card from early in Pouvillon's business. Note the crossed out address of 99 to 48 Rue de Bonvillers. Pouvillon married his first wife Anne Emily Soissons in October of 1902 and set up his first shop

that same year in a storefront at 99 Rue de Bonvillers which was owned by and very near a another building occupied by his father in law, Emile Soissons, where he ran a coffee/tobacconist shop. Pouvillon had one son, Paul Emile, from this marriage. His first wife passed away in July of 1913. In August 1914 he was mobilized for the war that was descending upon France, but in a few days was assigned to an auxiliary unit effectively keeping him out of combat. This may have been due to the title he earned in 1898 of "Ouvrier d'Art", which also exempted him at the time from the normal mandatory duration of military service. In December 1914 at the dawn of WW1, he marries his second wife, Anne Camille Tardy and was allowed to return to his home town in 1915 where he spent the rest of the war. Shortly after the war ended he moved his business to the second location at 48 Bonvillers; a building on the same street and owned by his parents. The word '*bijouterie*' or "jeweler" is also crossed out as he now was concentrating his business on watch and clock repair. He would remain at this location for the rest of his life. It appears he was thrifty man since he did not have new calling cards reprinted after the change in address and occupation.

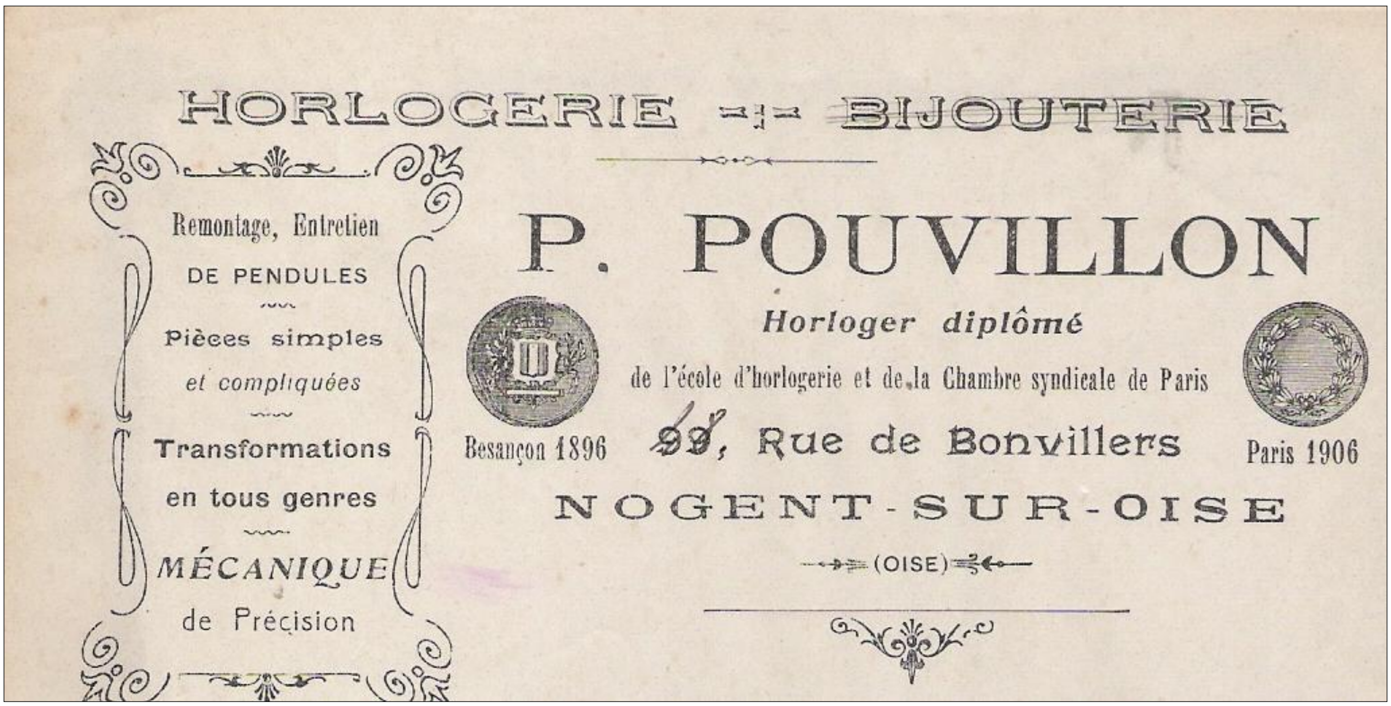


Figure 2. Pouvillon's business card from shortly after WWI, c. 1915

Figure 3 depicts a street scene from Pouvillon's home town c.1903 and shows him as well as others in front of his first shop location, which is the building with the outdoor street clock affixed to the front of the second floor. Pouvillon is above the arrow. Figure 4 shows Pouvillon, left, in front of the tobacconist shop owned by the in laws of his first wife, c.1910.

Not much is known about Pouvillon's life. However after the outbreak of WWII and the fall of France in June of 1940, Pouvillon had feared the his clock may catch the fancy of coming conquerors so he hid his clock the best way he knew how. He took it to pieces and scattered them amongst the other clocks in his shop.[9] He had good reason to be afraid; the Germans had looted Poland, Austria and Czechoslovakia on a mass scale. Not only museums and wealthy households were affected. In 1942 the Germans set up M-Aktion in France (M for Möbel, meaning furniture) which systematically looted anything of interest. By the time Germany left France in 1944, 71,619 dwellings had been sacked representing over one million cubic meters of goods filling 29,436 railroad cars.

Figure 3. Street view of Pouvillon's shop, c. 1903 with Pouvillon pointed out by the arrow.

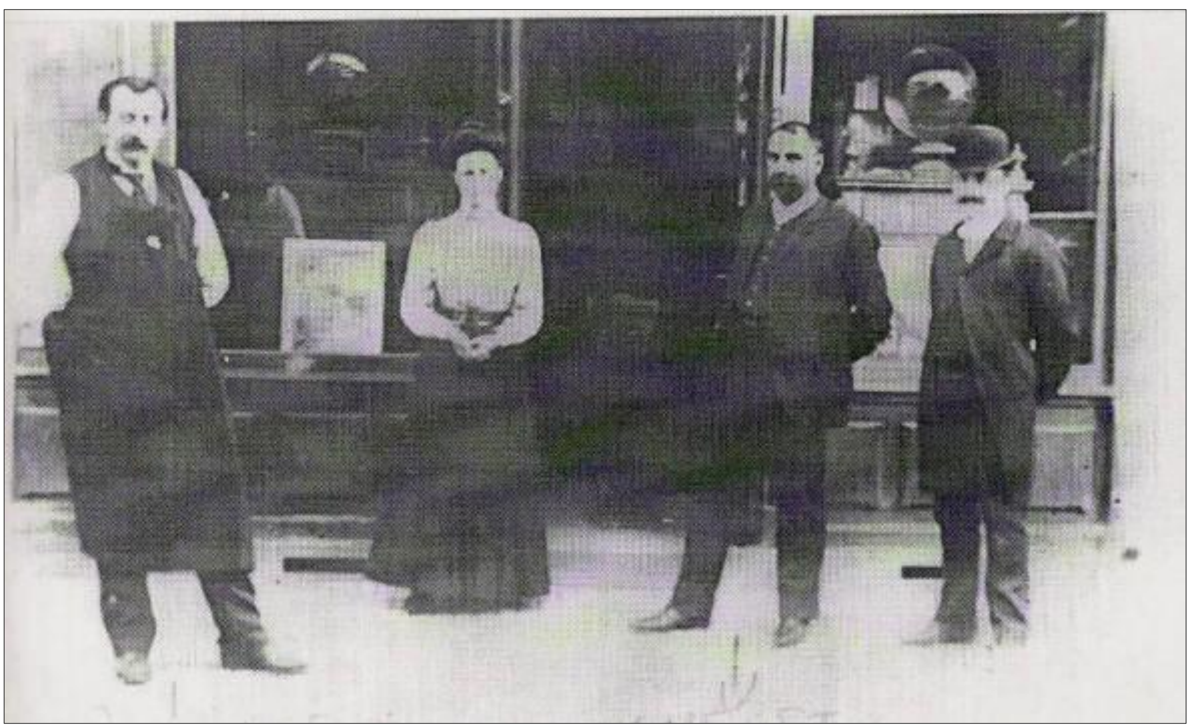
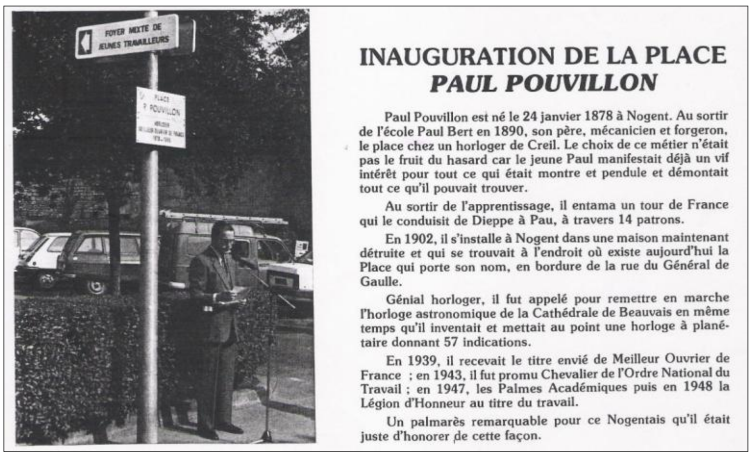


Figure 4. Pouvillon, far left. The other people are unknown, but may be Pouvillon's first in-laws, c. 1910

There were no children from his second marriage and his second wife passed away in March of 1953. Pouvillon next marries Heloise Picout, in January of 1954 at the age of 76. It appears Pouvillon did not like to

stay unmarried for long! In 1969 Pouvillon passes away at the age of 91 and his last wife dies a few days afterward. They lived, as indeed Pouvillon had since 1915, above the workshop he inherited from his parents and which contained his clock collection including his astronomical clock.

The building housing Pouvillon's home and shop had been purchased years earlier on contract by the town council of Nogent and this supplied him with a monthly payment in return for taking possession of it upon his and his wife's death to make way for a municipal parking lot. Figure 5 shows the dedication ceremony of the place where Mr. Pouvillon's home and business stood before being razed for that parking lot; plainly seen in the background. The lower square dedication sign in the photo says "Place de Paul Pouvillon, Meillieur Ouvrier de France, 1878 – 1969". The adjacent text is a brief biography of Pouvillon mentioning his awards as well as his astronomical clock claiming that it had 57 complications.[2]



INAUGURATION DE LA PLACE
PAUL POUVILLON

Paul Pouvillon est né le 24 janvier 1878 à Nogent. Au sortir de l'école Paul Bert en 1890, son père, mécanicien et forgeron, le place chez un horloger de Creil. Le choix de ce métier n'était pas le fruit du hasard car le jeune Paul manifestait déjà un vif intérêt pour tout ce qui était montre et pendule et démontait tout ce qu'il pouvait trouver.

Au sortir de l'apprentissage, il entama un tour de France qui le conduisit de Dieppe à Pau, à travers 14 patrons.

En 1902, il s'installe à Nogent dans une maison maintenant détruite et qui se trouvait à l'endroit où existe aujourd'hui la Place qui porte son nom, en bordure de la rue du Général de Gaulle.

Génial horloger, il fut appelé pour remettre en marche l'horloge astronomique de la Cathédrale de Beauvais en même temps qu'il inventait et mettait au point une horloge à planétaire donnant 57 indications.

En 1939, il recevait le titre envié de Meilleur Ouvrier de France ; en 1943, il fut promu Chevalier de l'Ordre National du Travail ; en 1947, les Palmes Académiques puis en 1948 la Légion d'Honneur au titre du travail.

Un palmarès remarquable pour ce Nogentais qu'il était juste d'honorer de cette façon.

Figure 5. Dedication ceremony, c. 1971

Upon the death of Pouvillon's wife the house was quickly emptied to make way for the demolition. Since both he and his wife died within days of each other there may not have been preparations made for the proper disposition of their belongings. Pouvillon was estranged from his only son and he gave everything away including the astronomical clock to a local charity shop known as The Friends of Emmaus, not unlike a Salvation Army or Goodwill store. It is likely that Pouvillon was engaged in one of his many revisions on clock when he passed away leaving it disassembled. It is unimaginable that if it were whole and intact that it would have been found in a state of partial disassembly at the time a clock dealer found it at the charity shop, paying $1000 for it. He, in turn sold it to another dealer for $5000 who then tried to sell it to the Time Museum, Rockford, Illinois in 1978 for $100,000, without success.[3] This is not surprising as the museum had purchased the Rasmus Sornes astronomical clock in 1970, a far more substantial example of horological complexity, for $50,000.[4] In 1983 a Paris dealer, Jean-Pierre Rochefort bought the clock. His sale advertisements for the clock begin in the September 1983 issue of Antiquarian Horology, figure 6a. He exhibited the clock in 1984 at the biennial Paris Antique Dealers Fair where it was purchased by a private collector. [5]

Notice the inordinate number of planets, there are double the correct number. Someone, probably the dealer who tried to sell the clock to the Time Museum, had added the planets to fill the extra attachment points in the orrery collets. This is why there are so many more planets than actually exist. There is further discussion about this later in the article. It next comes to the public eye at the auction house of Antiquorum, Geneva, Switzerland, April 23, 1995, (Figure 6b) [6]. By this time all of the planets were lost. It next appears at Christie's, London, December 9, 2009 in largely the same condition [7]. It is clear from these photos that all of the subsystems we found to be missing were not present in any of these photos.

If one looks carefully at the photographs of the clock from these three sources, all of which took good pictures of the clock, we can see that the movement has remained unchanged from 1983 through 2010 (with the exception of the planets). Therefore, it seems reasonable to assume the missing parts and depredations that

the clock suffered from later repairers took place during the nine years between the time it left Pouvillon's house in 1969 until its acquisition and failed sale to the Time Museum in 1978.

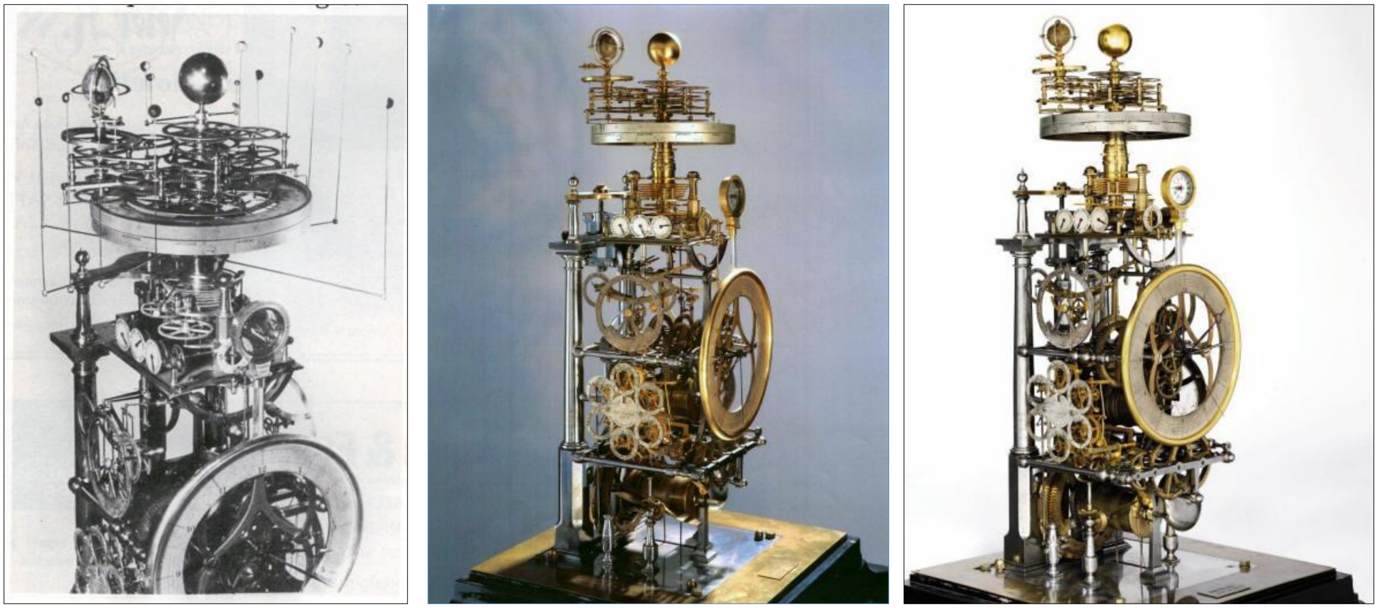


Figure 6a, b, c. Photos of the movement taken in 1983 Paris clock dealer, 1995 at Antiquorum and 2009 at Christies.

Description of the clock

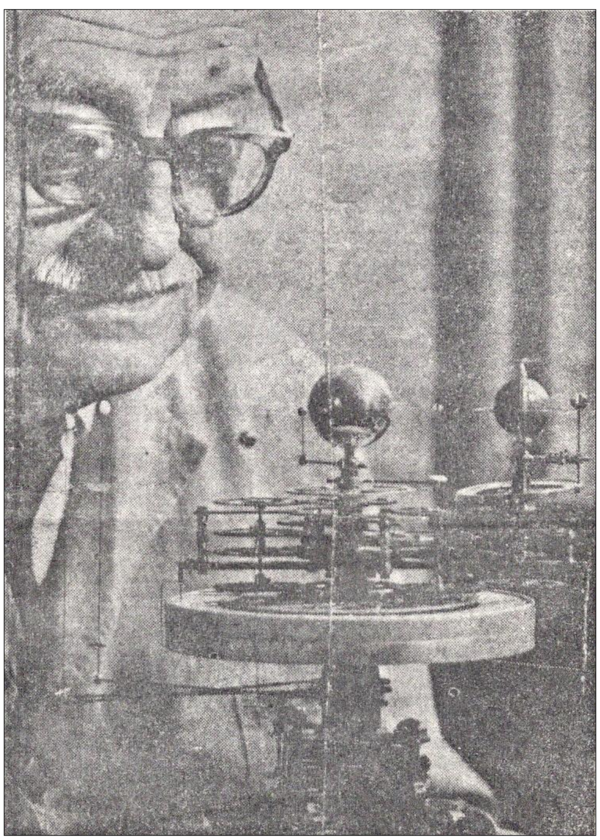
The Pouvillon astronomical clock is a two train weight-driven movement of two week duration using count wheel hour striking and a half hour passive strike, with a pinwheel escapement and one second pendulum. It is extraordinarily complex for its diminutive size. While the overall clock with its wood base is 20”w x 55”h x 20”d, the movement measures only 6”w x 20”h x 6”d, and yet has between 44 to 57 complications, depending on how strictly one wants to define these. But even at the low end, it is an incredible achievement. In my opinion the real genius of this clock’s creator is in his overall design; in particular the frame. When one looks at the clock it appears that everything inside floats in space, the frame recedes, nearly disappearing. It is the wheels, arbors, levers, cams and other internal intricacies that come to the fore. I call this a “space frame” and it has rarely been seen in other skeleton clock designs, (Figure 12, page 10). The dials appear uniformly on four of five possible sides of the rectangular shape, the sixth being the base. These also occur within different indentations from vertical. Additionally, there is the combined tellurium and orrery that crown the entire movement, (Cover photo, Figures 12, 13).

Pouvillon designed this clock to show various astronomical indications. But part of this clock was meant to serve as an ecclesiastical device, in other words to serve a religious purpose. Some of the complications and indicators are employed in the complex calculation of the moveable date of Easter. Twelve other religious events are then determined around this date.

There are only two photographs we have been able to obtain of the clock that we know are from the time before Pouvillon's death, because he appears next to the clock in each one, Figure 7a and b. The first is from a Paris newspaper article in 1953 [8] and the second from an undated photo in an article written about this clock in the Summer 1985 issue of the French language publication, Horlogerie Ancienne [1]. These two photos, poor as they are, have proved invaluable to recreating a subsystem that has been missing from the clock since at

least 1983. Given the delicacy of the clock mechanism and the meandering path it has taken over the past 42 years, it has survived in remarkably good, if somewhat incomplete, condition. The clock's wood base did not fare so well and there were many areas of damage, worm infestation and sloppy repairs. Some of the more serious damages were the result of an accident the base suffered in the 1950's while in route to an exhibition.[9] Sometime afterward and before it was next seen exhibited in a Paris antiques dealer show in 1982, the base was spray painted a glossy black to hide the damages, improvised repairs and wood filler sections. It was originally a walnut grained finish and that base has now also undergone full restoration to its original finish.

I had struggled for over a year to gain as much biographical information on Paul Pouvillon as well as any documentary evidence on the clock as it would have been originally configured before his passing. Many phone calls and emails through French speaking intermediaries to officials of Nogent-sur-Oise, the home town of Pouvillon were made with scant results. The town newspaper did run an article about the restoration process asking for any local support in terms of information, (Appendix C). This brought forth two helpful sources, especially a town resident who is interested in the genealogy of the town and knew a great deal about Pouvillon's family tree, but unfortunately no photos.[2] I even ran an advertisement in the print and on-line versions of the Paris newspaper, *Le Parisian* offering a 500 Euro reward for any useful information, especially in the form of photographic evidence, there were no takers (Appendix C). Furthermore,I had a person within France search the archives of the organization that awarded Pouvillon his *Meilleur Ouvrier de France* award. Those records were mostly missing. It seems odd to me that a man who was so celebrated in France and in particular his home town would generate such a lack of interest. It is from this small base of documentation that I had to engineer a complex restoration and why we had to more often than I'd had liked, make some suppositions about the original state of the clock.



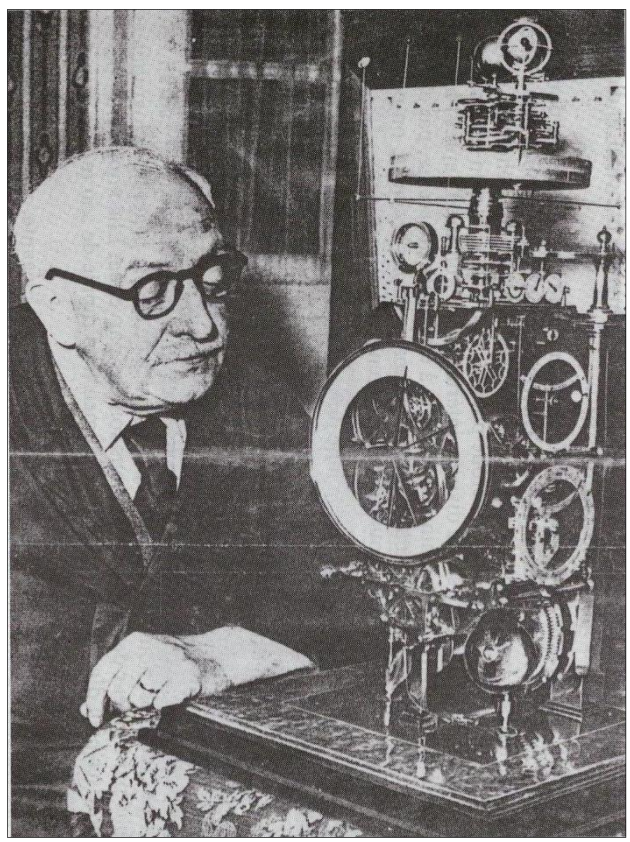


Figure 7a and 7b. Pouvillon with his clock, c. 1953

Figures 8a-c. Various styles of skeleton clock frames, all using conventional plate and spacer design to secure the wheel works.

In the vast majority of clocks, the movement is clothed in a decorative exterior case of wood, stone, metal, porcelain or some combination of these. Skeleton clocks have an exterior case made of glass or sometimes plastic and are designed to let the observer view the clock movement; it is the movement frame that takes center stage. These can take the form of allegorical architectural designs based on famous churches and other public buildings or complex and elegant curvilinear designs like those of Evans or Condliff, (Figures 8a-c). This makes sense since in most clocks there are only a limited number of components that exist between the frames. Even in the most complicated conventional three train, quarter striking clocks one would find only between twelve to sixteen wheels and associated strike control mechanisms. So the designs of most skeleton clocks focus on the frames. Both conventional and skeleton clocks generally share the same type of frame construction. Plate and spacer construction has two solid plates held parallel and secured to each other by a series of pillars and in between these plates the wheels as well as the rest of the mechanism is supported. In skeleton clocks the nomenclature of the plate is changed to frame when that plate has been fretted out or skeletonized but both still perform the same function.

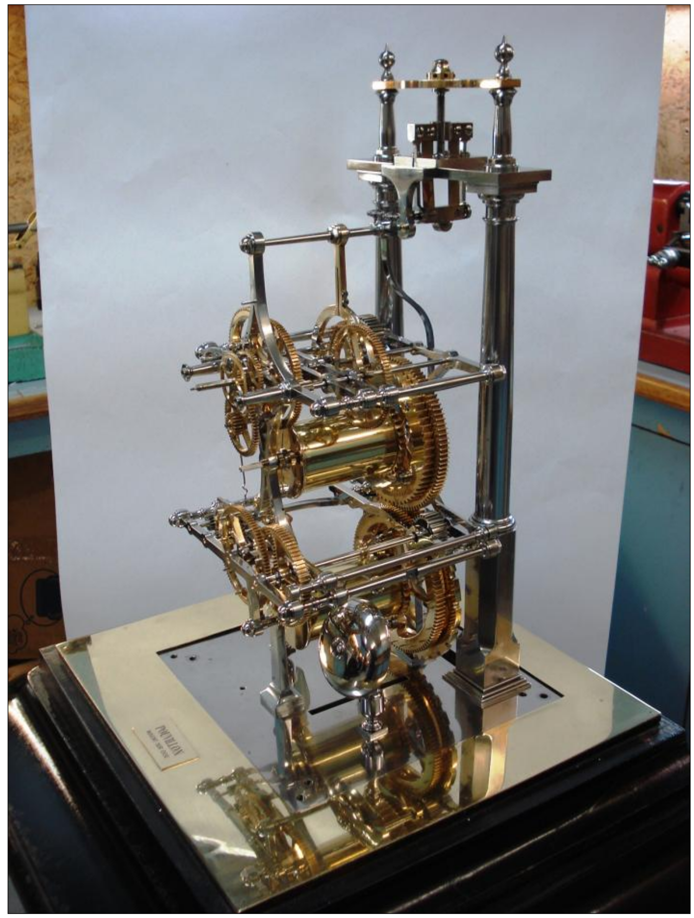
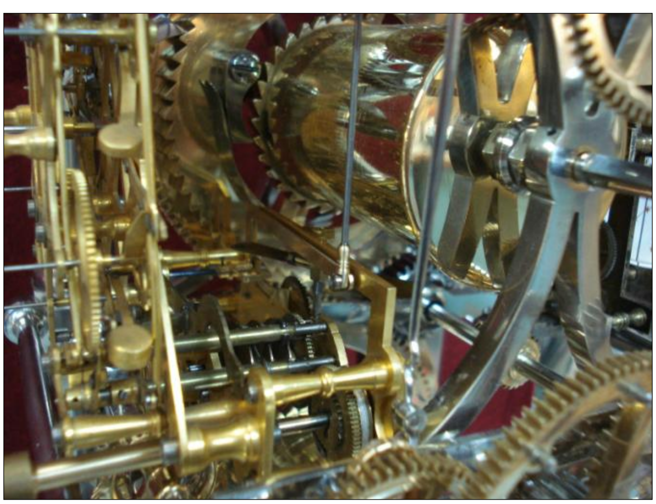


Figure 9, 10. Pouvillon's 'space frame' design. Here the frame allows the interior components to take center stage.

In Pouvillon's clock there is a wealth of internal components to work with that have nothing to do with the frame. His insight was to have those parts take center stage and allow his incredibly complex frame to fade into the background. I call this a 'space frame' design and its use is rare in horology since one needs a very complex mechanism to make this work, (Figure 9). In this example we have over just over fifteen hundred individual components squeezed into less than one-half of a cubic foot of space.



Figures 11a-g. Examples of the interior movement's complexity and unusual component placements.

There are many parts that have a 'quirky' look to them – long rods connecting to bevel wheels that are not always at right angles, (Figures 11a-g). Wheels, cams and levers are at different angles to each other as well as the viewer. This is all very different from the orderly way components must be arranged between two parallel positioned plates, which is the conventional plate and spacer design. Most of the clock was made over a ten year period, but other changes and additions and in one case an added component from another clock continued for an additional 20 years. During this time Pouvillon's skill and style of fabrication evolved and this is reflected throughout the clock's structure, further reinforcing its anachronistic quality.

Figures 11a-f, continued.

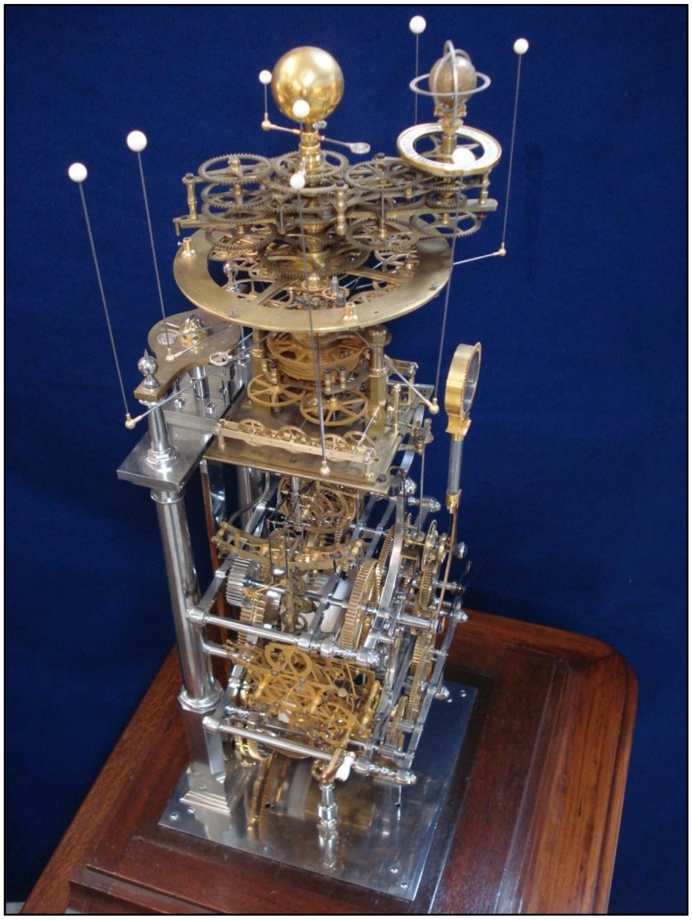


Figure 12. Complete movement stripped of all dial work

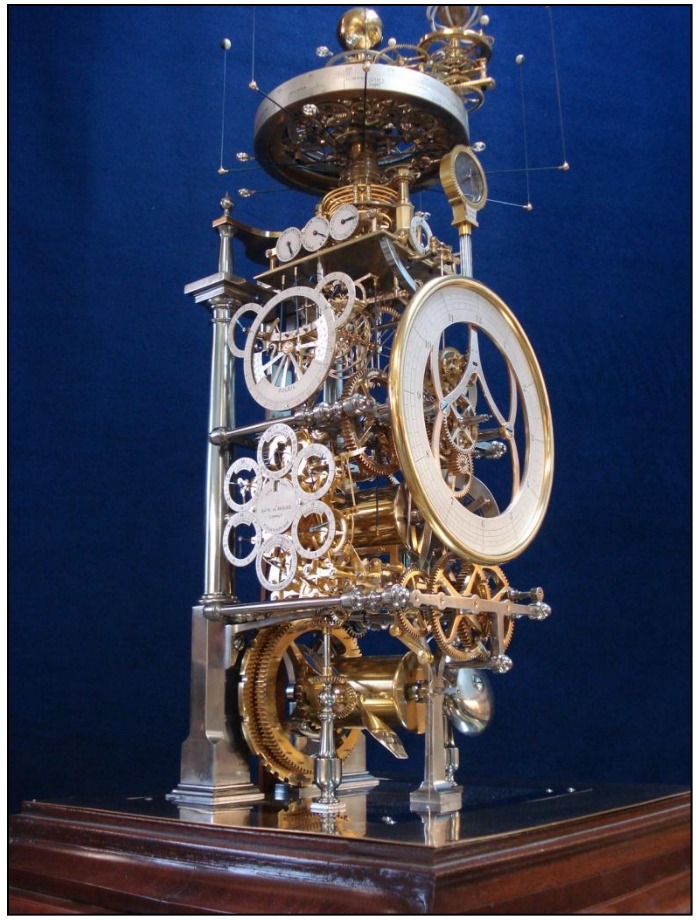


Figure 13. View from below

There is currently an interesting artistic, literary and social movement that goes under the genre of *Steampunk*. It combines the steam-driven mechanical era of Victorian-Edwardian England with current technology to produce a hybrid science fiction fantasy. One of the hallmarks of this is anachronistic, Rube Goldberg-reminiscent styles of machinery and in particular time machines and clocks. The recent Oscar winning movie Hugo comes to mind. It's interesting that Pouvillon first began this clock at the close of the Edwardian era marked by the conclusion of WWI, (see next section). So what we have here is artifact that could have been dreamed up today in an effort to hearken back to an idealized Steampunk style machine from that era but was actually created close to the original time frame with the qualities that we would recognize as a marriage of that time period and our current idealized design notions, (Figures 12, 13). Notice how muted the frame is in comparison to the rest of the components in the clock.

This is certainly an unconventional skeleton clock in every respect. But for people who are fascinated by the mechanical aspects of a clock mechanism and for those who think that when it comes to complexity *more is better*, and especially for the true 'gear head' this is about as good as it gets.

Chapter 2. A hypothesis on the Time Line of the Clock's Construction

Based on the observations gained during the deconstruction of the clock we have come to a hypothesis about the time line in connection with the building of this clock. It has been widely quoted in articles and in particular the two auction house catalogs through which this clock has passed, that the movement was a masterpiece made by Mr. Paul Pouvillon between 1930 and 1939. We have observed that the clock when stripped of all of its complications looks to be a complete clock. One that easily could have been conceived and executed as is and with no thought of future additions or alterations. This clock was a two train, hour striking clock sharing many design elements seen in small tower clocks and are described below:

A. The frames are made of wrought iron rather than brass.

B. The rear frame pillars are turned, not unlike those seen in the tower clocks which Pouvillon was familiar, specifically the church clocks in Strasburg and Beauvais, France.

C. The dial setting clutch mechanism for the time is identical in design to those used in smaller tower clocks of the day by other French makers, Schwilgue, Ungerer, Lepaute and Gugumus

D. The oil holes used in the frame members are seen only on tower clocks; not on domestic movements

E. The massive pendulum bob at 7.085 kg or 15 lb 9.5 oz is what would be expected in a regular sized tower clock.

F. As a result of the heavy bob the entire pendulum suspension system takes on the robustness of a tower clock.

G. The fine pendulum adjustment is turned using a Tommy bolt is similar to many types used in tower clocks.

H. There is a safety catch to prevent the pendulum crashing to the floor in the event of the suspension spring breaking; a feature unheard of in domestic clocks, but quite common in tower clocks.

I. The construction of many of the main frame wheels have integral collets which are then pinned to the arbor. The collets are not permanently attached to the arbor.

J. Other wheels are single-bolted to their collets as often seen in tower clocks.

K. The bevel wheels are cast in the manner of tower clocks with the interior spokes coved in relation to the rims. A few of the larger steel pinions are also made this way.

L. The construction of the going and strike barrels are exactly as those found on smaller tower clocks, with removable, screw down collets that act like nuts on a thread cut into the arbor.

M. The pins on the escape wheel are each set within collets. Something sometimes found on large tower clock pinwheels. On domestic clocks the pins are set directly into the wheel rim.

N. The escapement pallets are removable and are held with a screw. The pallet depthing is adjustable via an adjustment screw acting upon a slit along the vertical axis of the escape pallet assembly. While this second arrangement is not unheard of in domestic clocks, it is quite common in continental tower clocks.

O. Lathe turning centers left in the ends of the winding square arbors, a common feature in tower clocks, but unacceptable in domestic clocks.

P. The strike hammer lift cam is fabricated with separate components the same as some French tower clocks, in particular Collin-Wagner.

I believe Pouvillon constructed this proto-clock before 1930 as a standalone clock without consideration of later adding any complications. This is supported by the fact that none of the attachment points for the

complications were special-made within the frame. All attachment points are areas that were later filed flat and with holes that are often awkwardly placed. In many instances we see parts of the frame that were removed to allow for the positioning of a complication or peripheral component even to the point of impinging upon a previously placed pivot bushing. Entire complications or dials are sometimes held by only one screw due to the lack of pre-planned mounting supports. Following are a few examples.

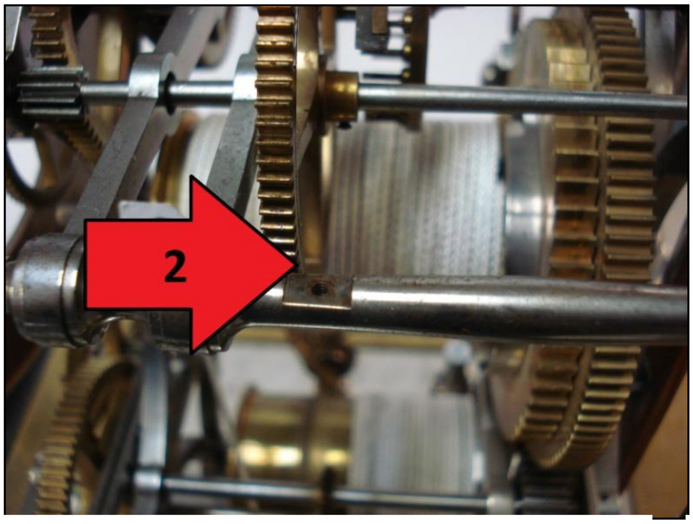


Figure 1. Single mounting point for lunar dial

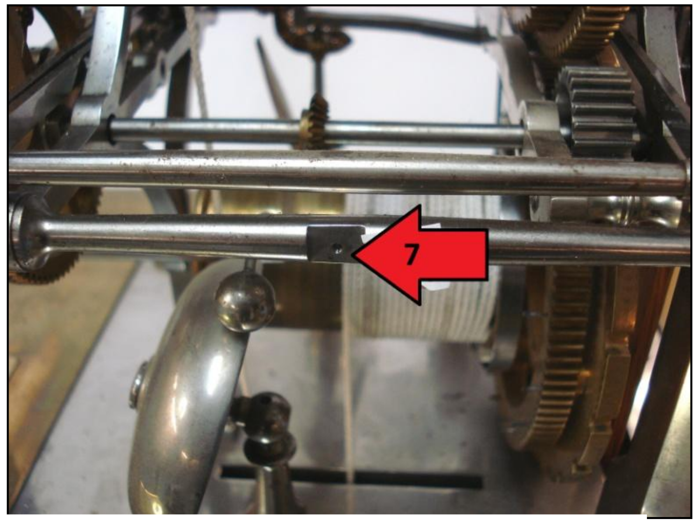


Figure 2. Single mounting point for lunar train

Figure 1 pointed out by arrow 2 shows a flat machined on a pillar for the attachment, the only attachment point, securing the lunar dial. In figure 2 arrow 7 shows another flat machined on a pillar for, once again, the only attachment of the lunar train.

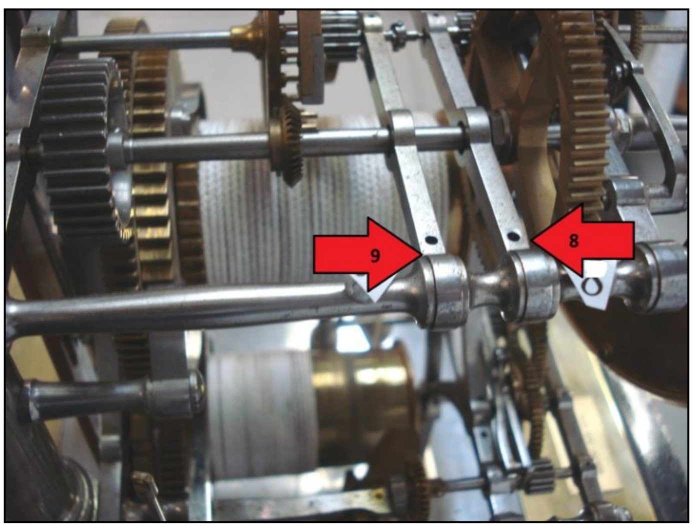


Figure 3. Holes for sunrise/sunset complication

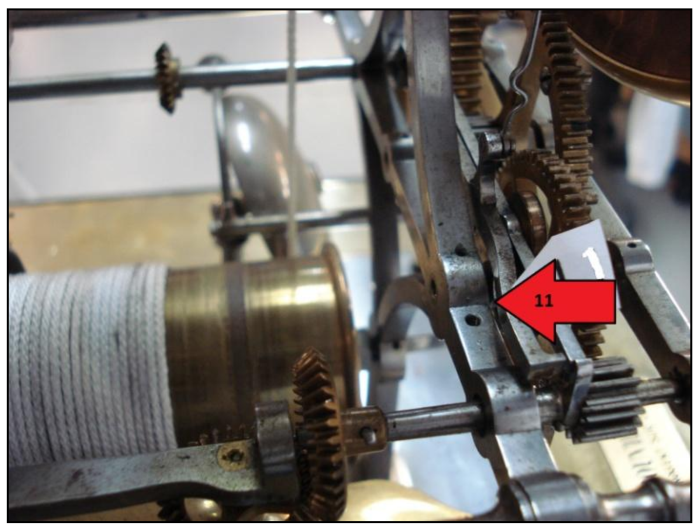


Figure 4. One of two holes for the Easter calculator

In figure 3 arrows 8 and 9 indicate the two mounting holes for the sunrise/sunset complication. Again these holes could have been drilled in the frames at a later date. Next in figure 4**,** arrow 11 shows we have another screw hole which is one of the two attachment points for the Easter calculator again the same condition applies. An interesting nearby feature is the oil hole just above which is common in tower clocks but rarely seen in domestic clocks.

Figure 5. Fly fan potence showing later alterations

Figure 6. Same part from shaved side, showing exposed bush

Figures 5 shows a potence with a wheel bush supporting the bevel drive to the strike fly. If one looks carefully it is clear that the upper side of the part which now is cut into the bush was originally flared in the same manner as the opposite side which meets flush with potence foot. Next we see the same part showing where the flair has been cut away, impinging on the previously installed bush, in order to provide sufficient clearance for the Easter calculator. (Figure 6).

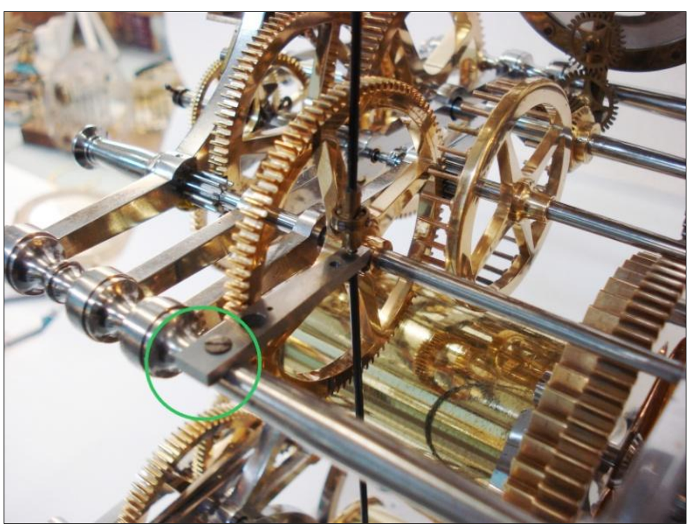


Figure 7. Rough part that supports universal joint

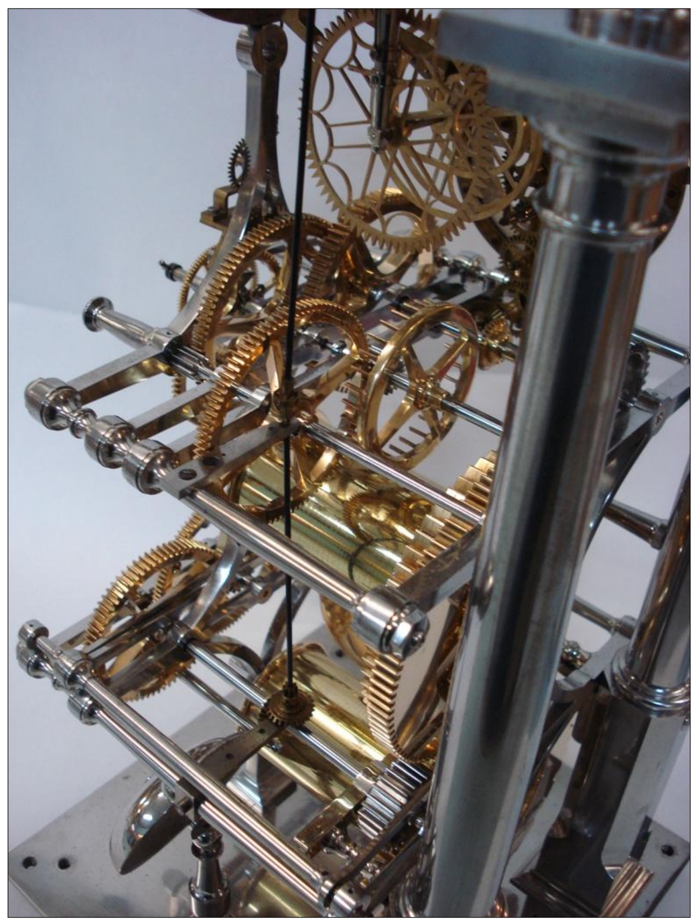


Figure 8. Kinked arbor using universal to avoid obstruction

Figure 7 shows a universal joint whose arbor below the joint is positioned by a metal strip secured to the second frame pillar and this guides a ‘kink’ in the vertical arbor enabling it to clear one of the time train arbors. The same strip also secures the lunar dial. Note the circled area where this strip is joined to the Phase One cross frame pillar. This is done by having a flat filed onto the frame pillar with the simple rectangular metal piece fitted. There is no effort to blend this piece in as would have been the case if it was conceived as a whole in the Phase One design. Figure 8 is another view of the vertical arbor and the bend introduced by Mr. Pouvillon to bypass a time train arbor. I think that had he planned this addition initially, he would have made a slight change in the size or position of this time train arbor or changed the position of the strike arbor where the bevel gear drive terminates to prevent the misalignment from an otherwise avoidable obstruction.

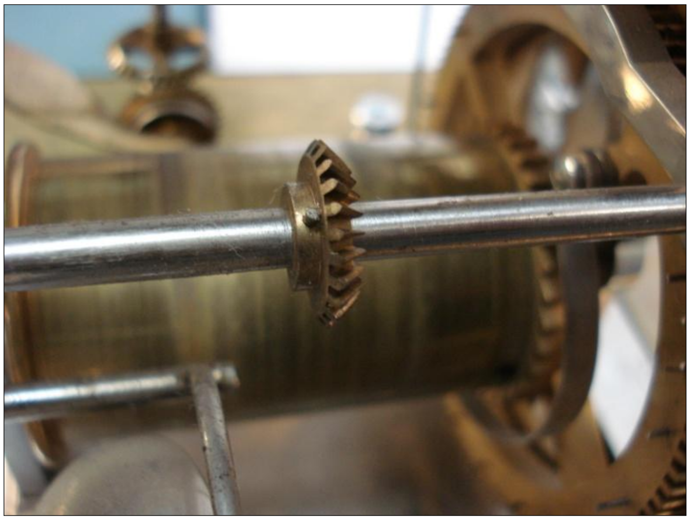


Figure 9. Later added bevel without mounting provision

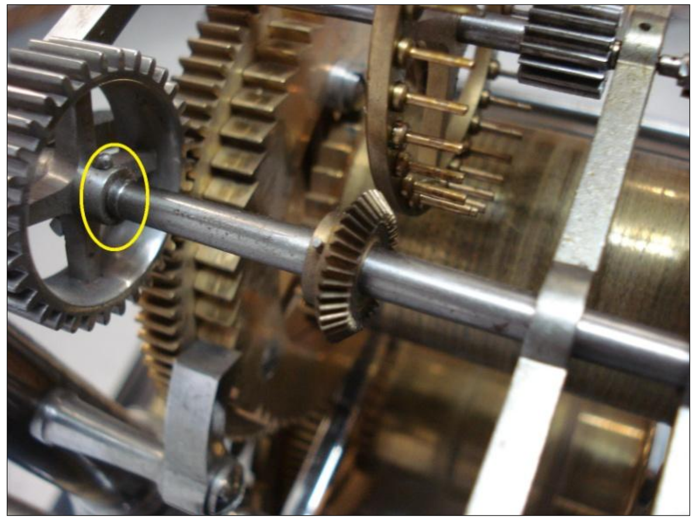


Figure 10. Phase one wheel mounted with proper provision

All of the drives to the complications are mostly in the form of bevel wheels and are attached to the phase one arbors in what appears to be an ad hoc fashion. There are no provisions made for correct fitting of these later bevels on the tapered arbors, (Figure 9). In the phase one clock, all wheels had proper parallel mounting points on the otherwise tapered profile of the arbor, (Figure 10). None of these conditions would have been present with a clockmaker of Pouvillon's talent if the clock was pre-planned with the bevel drives for the complications. The fact that the phase one clock stands as a beautiful example in its own right completely stripped of all complications stands as testament to this, (Figures 12-14, next page).

So one might ask how given the flaws in workmanship I have pointed out could Pouvillon have won the *Meilleur Ouvrier de France* in 1939? I can only think of two reasons. The first is that the overall presentation is exceptional, but I think a major consideration is the context of the time the award was given; the year of 1939 was a precarious time for France. There may not have been a lot of competition that year. But even with the obvious construction criticisms, Pouvillon exhibited great talent and imagination in achieving a final product that was not only intricate and interesting to the viewer, but appears as a nicely integrated whole. This is all the more difficult as he did this in an entirely ad-hoc manner, over a long period of time, using some outside components and his evolving ideas into a clock that was already created at an earlier time for an entirely different purpose.

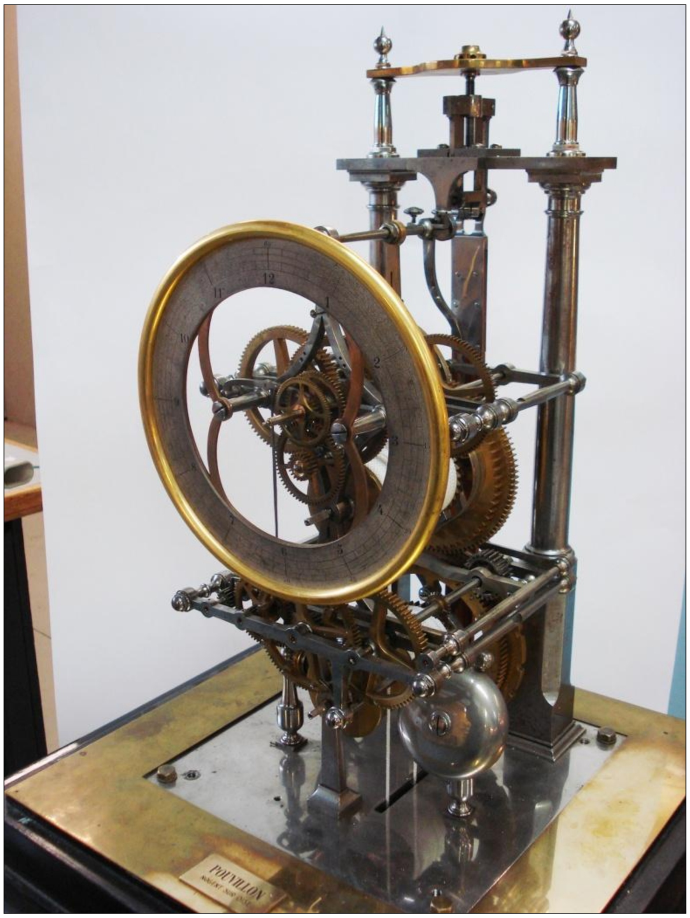


Figure 12. Three-quarter front view of phase one clock

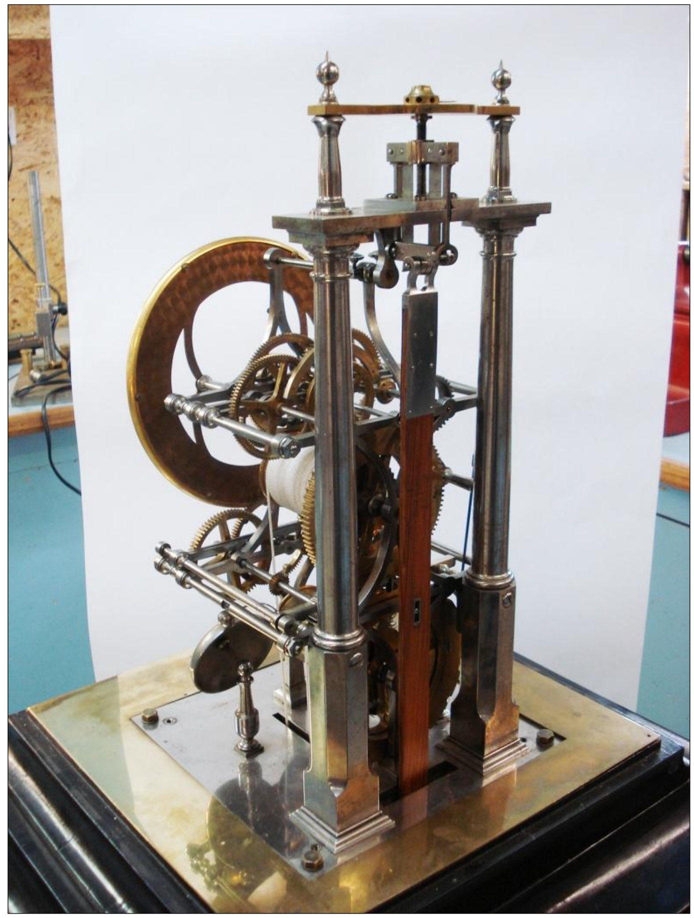


Figure 13. Three-quarter rear view of phase one clock

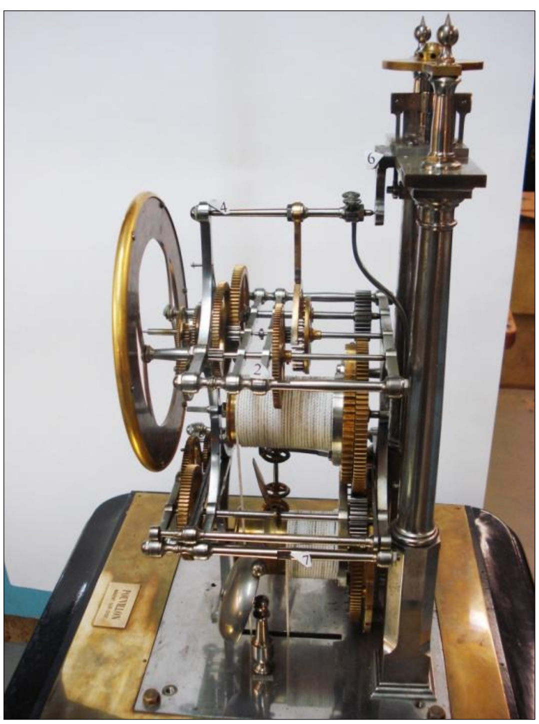


Figure 14. Side view of phase one clock

Below is the order that we think the clock was built based on our forensic observations and extant literature.

<u>Phase one</u> is the original small tower clock, going, and striking trains – no orrery. We believe this is *pre 1930* and when built was not intended for use as a base for the later complications. In other words it was built as a complete, stand alone, clock, probably between 1900 to the 1920's. There is greater wear on the parts within the Phase One clock than those we know were added later. The front dial as shown is not what would have been originally present and would have been somewhat smaller as evidenced by the dial-to-pillar spans created to allow the mounting of the larger dial ring. As is, it is out of proportion to the rest of the clock when it is the only dial present. Had this larger size dial been contemplated when the phase one clock frame was originally made it would have been a simple matter to extend the upper horizontal frame supports straight out to attach to the rear of the dial.

Phase two is just prior to 1930 and is the birth of the astronomical clock beginning with the addition of a tellurian Pouvillon acquired from another clock (not to be confused with the orrery controlling the outer planets which was by his own hand). That orrery mechanism is *below* the superstructure holding the tellurian and I believe this to be the first of his complications as many power feeds to other components located on the sides of the movement originate from this system. The tellurian is the only component that was not entirely made by Pouvillon and yet even here he remade the rotating frame components, making them more decorative than they were originally, (Figure 15). It is also the only complication that employs enamel dials. Figure 16 shows an identical tellurian in all respects, especially the enamel dials, but with a plainer rotating frame containing the same wheel works. This example appears on a movement signed by Antide Janvier. I have documented four other tellurians all made by the same hand as the one Pouvillon used. These have appeared on clocks made by Ferdinand Berthoud, Baltazar Pere, Giteau, as well as Janvier. [10] It appears there was an independent fabricator of this device who was subcontracted by these important clock makers for its inclusion into their work. On this clock the two silver bands surrounding the enamel dial, center star grill and upper star grill are Pouvillon's additions and will be examined later in greater detail.

Pouvillon's inspiration to build this clock may have come from his repair of the Vérеté astronomical church clock as noted before, or maybe it happened when he came across this tellurian. Perhaps while wondering how he could utilize this magnificent component he saw the possibilities of joining it to his existing small tower clock.

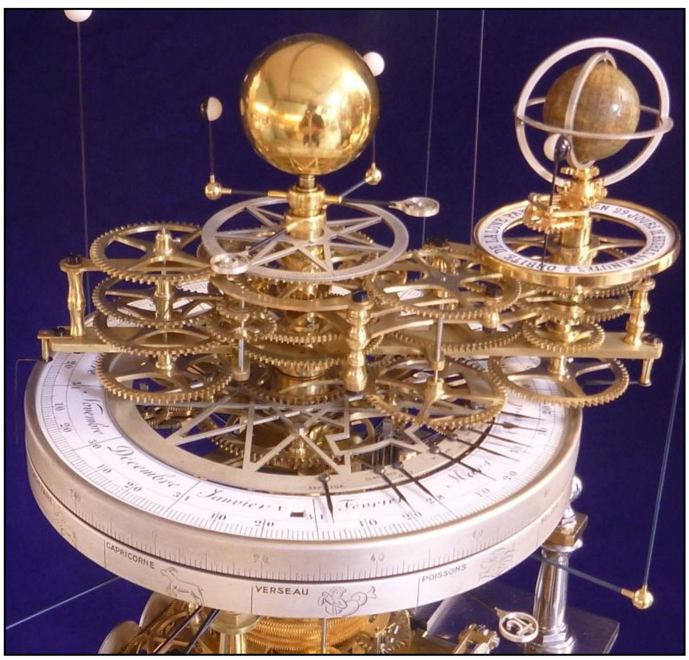


Figure 15. Pouvillon's tellurian

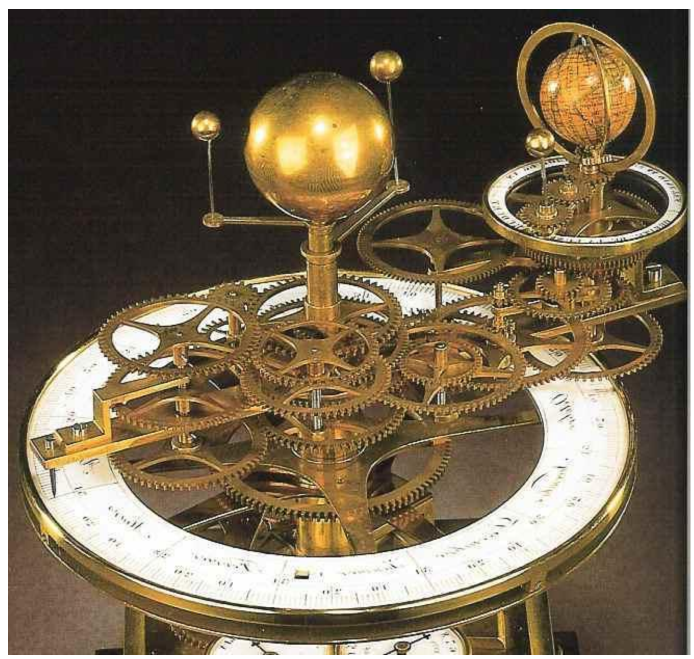


Figure 16. Nearly identical tellurian on Janvier movement, c.1790

Phase three covers 1930-1939. Here he begins his project to create the several complications on the front and sides of the phase one clock frame. These may not be all of the same components we see today. From a date stamped on the back of the Easter calculator's center calendar disc, it appears the calculator was completed sometime in 1946 and from the literature we know he had made a final adjustment to this system in 1953 to make the calculator perpetual, see phase five below. So either an earlier iteration of the calculator was there or something else may have occupied this space when the clock was exhibited in 1939. It is unlikely Pouvillon would have left this area empty. Therefore the Easter calculator could have been either in the phase

three or phase four sequence. I think that probably an earlier, non perpetual form of the calculator was in the clock when Pouvillon was receiving his various acclamations in 1939. It certainly is the one complication that makes this clock stand out from most others. Considering that WWII may have disrupted his work, we feel that it is unlikely he could have designed and built the entire calculator in the one year or less between the end of the war and the date stamped on the calculator calendar disc.
Phase four is between 1946 through 1953; during this time he completes the Easter calculator and adds the seven small white dials around the base of the orrery wheel pack. The leap year, state of strike, the day and its zodiacal sign, the month and its zodiacal sign and the season.[1]

Phase five is 1953-1954. In a newspaper article dated 1953 it is reported that he conceives of the perpetual piece for the Easter calculator.[8] We know the Easter calculator has to be tripped annually, and this would have been from a missing assembly, the annual cam pack, that we have reproduced and which drives the glass mystery dial indicating 'sun time', as well as the sun rise, sunset shutters and length of day, length of night dials. We also know that for the Easter calculator to operate correctly the Epact dial needs an extra feed every 19 years. This will allow it to be perpetual for 400 years, or until an additional leap year is needed. This ability only applies to the six dials that ring the central Easter date dial; the center dial is not perpetual and is only good for 19 years. For a detailed discussion of how Easter is calculated using ecclesiastical tables which are derived from celestial events and how these calculations are reflected within this clock's calculator, please refer to my website.[11]

In a 1955 newspaper article it is reported that Pouvillon was working on a final indication, the rise and setting of the moon.[12] However, we see no evidence for this and in this effort we must assume Pouvillon failed and had added no other features past this date. By this time he was 77 years old. The lunar indicator on the clock is not a physical indication of the moon's position in the sky but is used in the calculation of Easter.

Chapter 3. The Restoration Process for the Pouvillon Clock

I now turn to the portion of this article that will deal with the repair and restoration of the Pouvillon astronomical clock. The restoration was undertaken by the clock making firm of Buchanan of Chelmsford, located in Australia and took just over one year of undivided time to complete.[13]

Below is a list of the clock's complications. Those that were disabled as found are in italics. The most conservative count comes to 44, while several articles written in the French newspapers at the time claim upwards of 57. It all depends on how one counts. For example I count all the planets in the orrery as one complication rather than each of the eight planets as a separate complication.

1. Mean solar time for the meridians of Greenwich and Paris
2. Equation of time
3. Day of week
4. Zodiacal sign for day of week
5. Month
6. Zodiacal sign for month
7. Leap year
8. Season
9a. Time of Sun rise
b. Time of Sun set
c. Sun's elevation
10. Length of day
11. Length of night
12. Ecclesiastical calculator, 'computus':
a. Dominical Letter
b. Epact
c. Golden Number
d. Solar Cycle
e. Indiction
f. Day of week
g. Day that January 1st falls on
h. Date of Easter
13. Strike position indicator
14. Day
15. Day's planet
16. Moon phase
17. Moon's age
18. Cyclical Lunar Month (used in determining epact, golden number)
19. Planisphere showing northern hemisphere at near 49^0
a. With dial showing stars at positions at different times of the day
b. Position of Ursula Major and Minor for an observer in the northern hemisphere
c. North, South transit time of the stars
20. Sidereal time
21. Tellurian depicting the two inner planets plus Earth and Moon system
a. Moon's nodes: rise, fall and 18.6 year precession
b. Year indication

c. Ring around Sun
d. Position of the Sun in the zodiac
e. Thirteen pointers showing various ecclesiastical moveable feasts related to Easter on tellurian dial ring
22a. Orrery demonstrating the orbits of the six outer planets through Pluto
b. Indications of where each planet is in the zodiac
c. A depiction of each planet's zodiacal sign
23. Precession of the Zodiac over a 24,806 year cycle

The clock as received was not in working order. There was a host of missing components which were lost during the period between the passing of Pouvillon in 1969 and the first time we have photographic evidence of the clock in 1983. These missing components would have disabled the functions illustrated in italics and amounted to over a third of the total complications the clock was originally capable of performing.

The restoration, as one might guess, was anything but straightforward. Below is a list, in chronological order of the restorations performed. It also follows a path from the obvious repair/replacement of what was certainly extant when Pouvillon built the clock all the way toward the end where we began to make some suppositions and finally at the very end, one pure addition.

Now let's outline exactly what has been done and why. Common repairs that one would encounter in a conventional antique clock repair are not discussed. Those might be pivot and bush repairs, general cleaning and polishing, dial refurbishing and any other cosmetic repairs. To examine a complete report of all repairs with videos and greater detail please, refer to my website.[11]

1. **Repair broken pendulum stick**
2. **Repair weight pulley system**
3. **Secure time train click spring**
4. **Replace broken glass drive tube in 'mystery dial'**
5. **Restore annual cam pack**
6. **Restore missing tellurian and orrery planets and attachment wires**
7. **Restore sunrise/sunset dial spiral bias springs, replace missing sunset dial hand**
8. **Restore sunrise/sunset shutter bias springs**
9. **Repairs to the Easter calculator**
   a. Restore automatic annual trip linkage, calculator to cam pack
   b. Restore warning and trip mechanism in calculator
   c. Restore calculator's perpetual Epact function
   d. Replace missing calculator drive chain and weight
10. **Restore orrery demonstration crank**
11. **Restore zodiac precession complication**
12. **Restore annual year indication**
13. **Create planetary signs to fill open orrery collet mounts**

1. Repair broken pendulum stick. The clock as received was not running. This may have been resolved by a conventional repair and cleaning of the existing movement. We found nothing actually broken or missing in the time or strike train except for the thin, wooden pendulum stick which was broken in one place. There was a previous repair to this stick in another area and it should be noted that the gilded pendulum bob, Figure 1, is very heavy in comparison to the stick at over 15 lb (7 kg), thus increasing the odds of such damage. We affected a repair using a metal brace riveted to the front and rear side of the flat rod in the same manner as the old repair, (Figures 1-4).

Figures. 1-4. Repairs made to the broken pendulum stick

The completed pendulum repair is shown in Figure 5, next page.

Figure 5. Completed repair; pendulum mounted in place

2. Repair weight pulley system. The pulleys used in the weight system were made of wood, and the pulley pivot bearing surfaces were simply worn to the point of non functionality. To get a two week duration on such a complex clock with less than one meter of drop, required the weights to be triple-compounded and so are very heavy. Over the years as the pulley bearing surfaces became worn, later owners began lashing additional lead weights onto the original cast iron blocks; see circled parts (Figures 8, 9). Since the pulleys are not normally seen, one might be tempted to simply replace these. Starting right here, the decision was made that in all repairs and restorations, all of the original parts must be retained*****. For the triple-wheeled pulleys we knew we would have to re-bush them and a wood surface was simply not a choice that would have had any lasting duration. In this instance we decided to use ball bearings that would still utilize the original arbors and fit within the existing pulley center holes, (Figures 6, 7).

*****See exceptions of Epact linkage, and manual trip lever in section 8 of this chapter and pedestal access door wooden panel, in chapter 4.

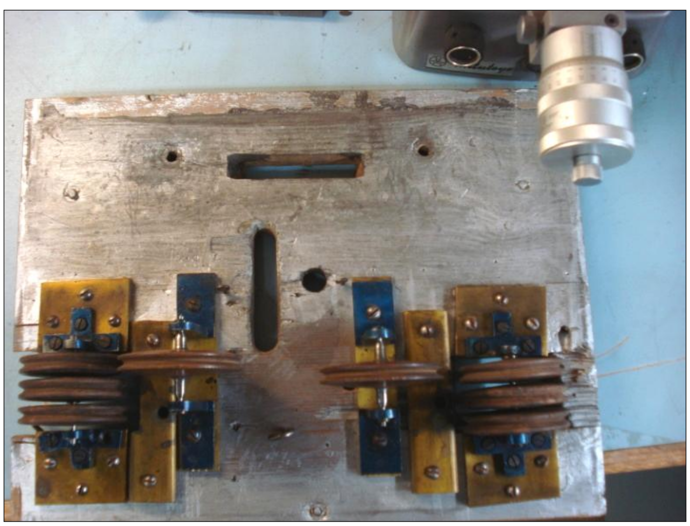


Figure 6. Pulley system as found.

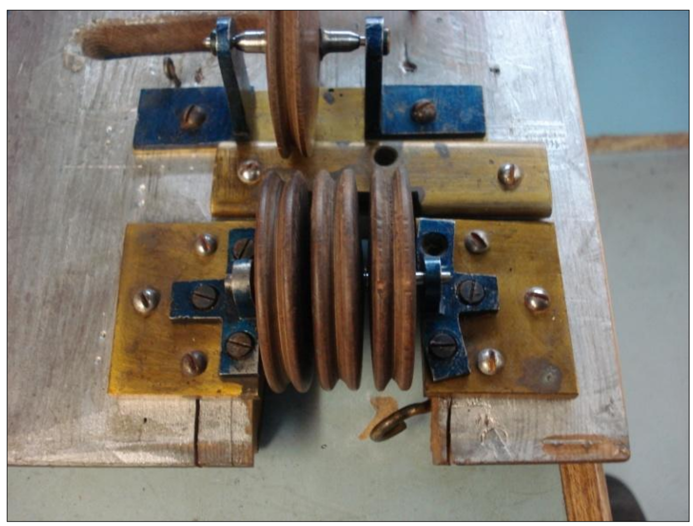
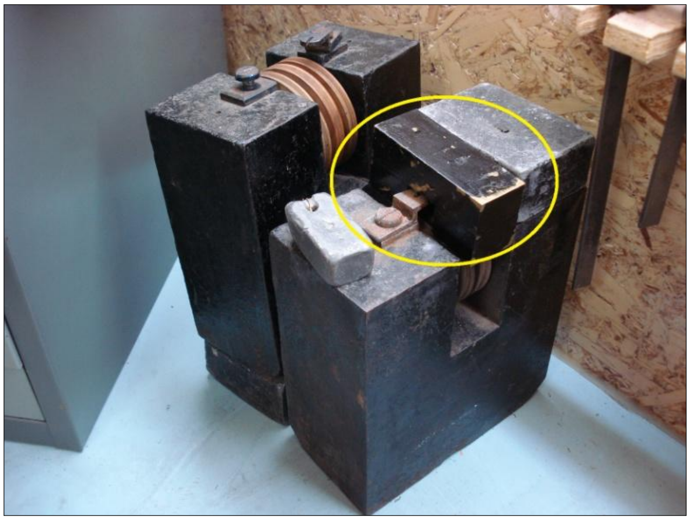


Figure 7. Close up of wood triple compound pulley



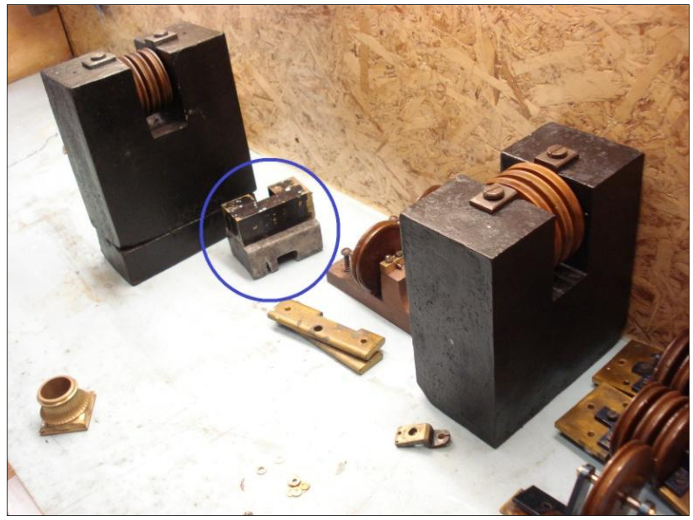


Figure 8. One block weight with added lead weight. **Figure 9. Both added weights removed, circled parts.**

3. Secure time train click spring. The attachment point for the click spring on the time train barrel had no positive securing point, (Figure 10). Unlike that on the strike barrel, which was secured by a square stud (Figure 11) the time barrel spring was held in place only by the friction of the bolt holding it to the drum's main wheel. Should this spring ever come out of position, a catastrophic runaway would occur. The obvious solution would be to have a locating pin installed. Since we did not want to alter the original artifact we used Loctite on this point.

Figure 10. Unsecured time train click spring. **Figure 11. Properly secured strike train click spring.**

4. Replace broken glass drive tube in 'mystery dial' and retouch dial. The front glass 'mystery dial' which indicates sun time or more accurately sundial time, as one would see from a sundial at the latitude of Paris, France was not functional. The nomenclature for the dial is derived from the genre of clocks created by the French horologist and magician Robert-Houdin in the mid 17th century. These had glass dials with hands floating in the center which appeared to have no connection to the movement, thus it was a mystery as to how they were driven. Many readers may be more familiar with the same concept employed in the 1950's by

Jefferson Electric in their *Golden Hour* series of clocks. The famous American magician Harry Houdini took his namesake from Houdin.

The dial was supported by a glass tube, which was intact, but an inner glass tube which drove the glass dial was shattered with most of that tube missing. Figure 12 shows the parts as found. Next the replacement tube is fabricated and shown next to the old, damaged tube, (Figure 13). The new glass tube was fitted to replace the one that was broken to bring back the mechanical connection to the dial. Figure 14 shows the completed assembly with Figure 15 showing the retouched glass mystery dial.

Figure 12. Mystery dial assembly as found

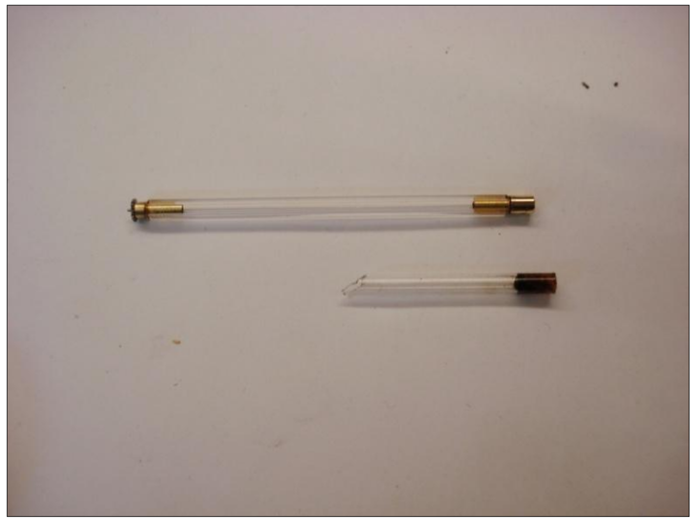


Figure 13. New glass tube next to old broken drive tube

Figure 14. Completed mystery dial assembly

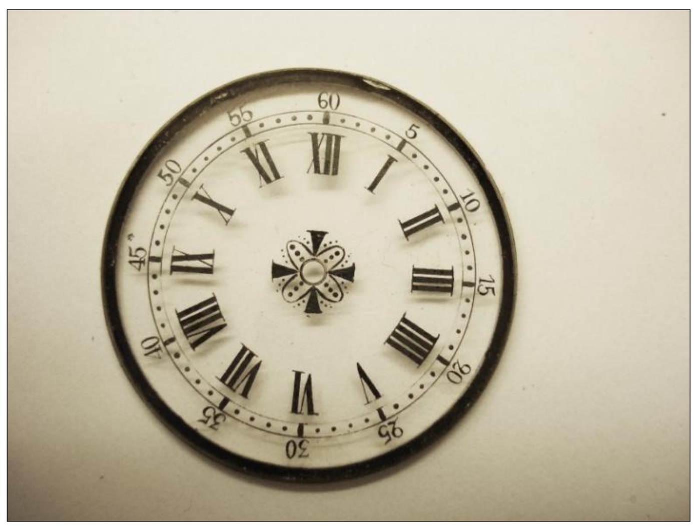


Figure 15. Retouched glass mystery dial

Figure 16. Numeral as found

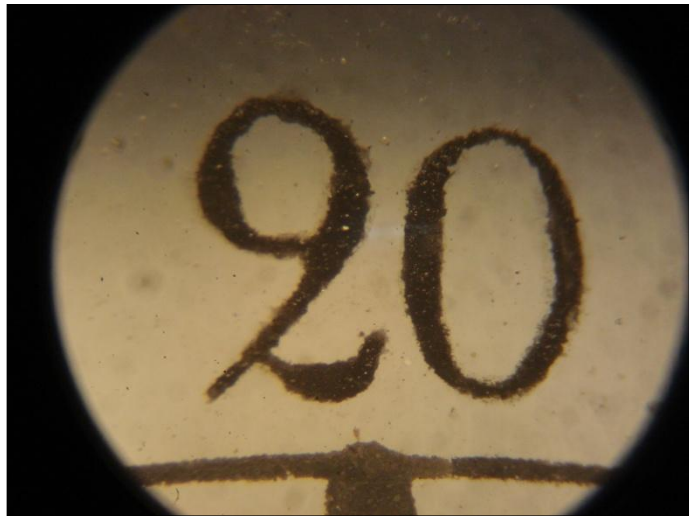


Figure 17. Numeral retouched, shown at 20x magnification

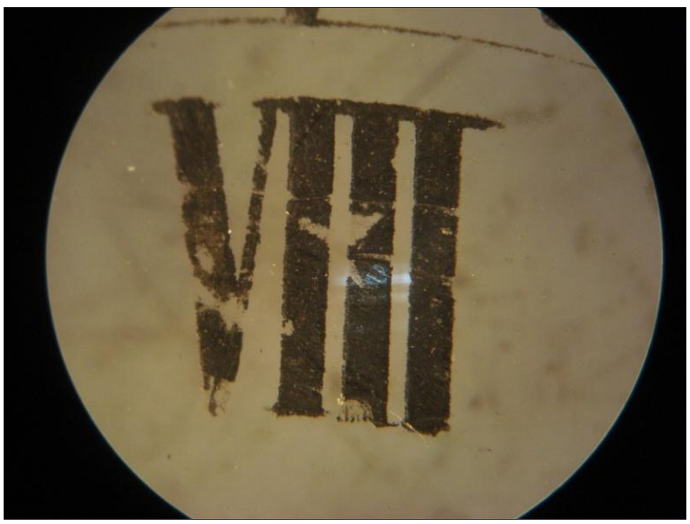


Figure 18. Numeral as found

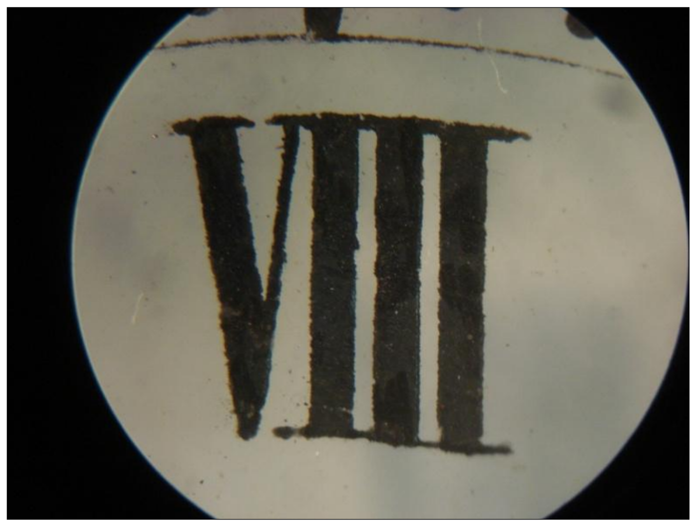


Figure 19. Numeral retouched, shown at 20x magnification

Some of the painted numbers on the dial face were partially rubbed off making parts of the dial illegible, (Figures 16, 18) and those missing areas were carefully retouched on the glass to fill in the missing sections only. The view shown is at 20x magnification, (Figures 17, 19) resulting in the legible dial shown in figure 15.

5. Restore the annual cam pack. Shown in figure 20 is a close up section of the photo of Pouvillon and his clock seen in, figure 7b, on page 6. This was very useful in revealing to us how the step-drive wheel for the annual cam pack should look like. Figure 21 shows our restoration of this part seen from the same perspective.

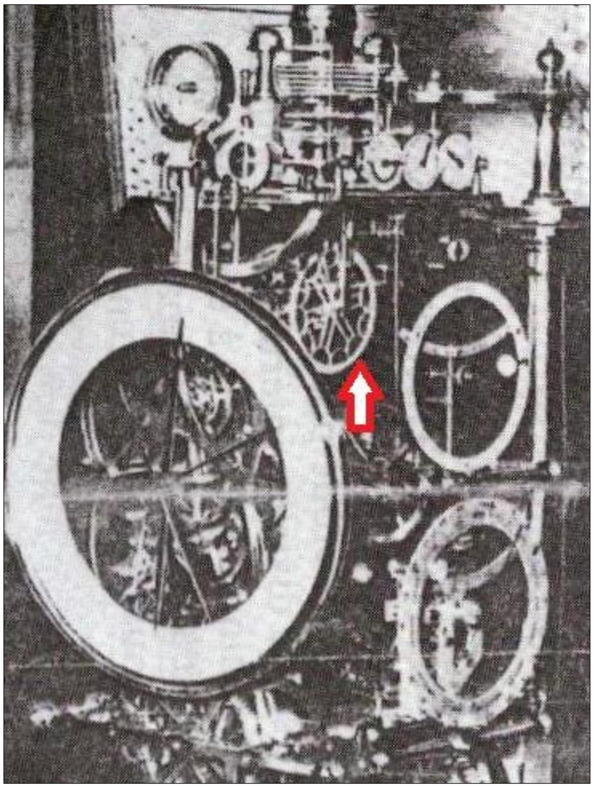


Figure 20. The annual cam pack step drive, c. 1953

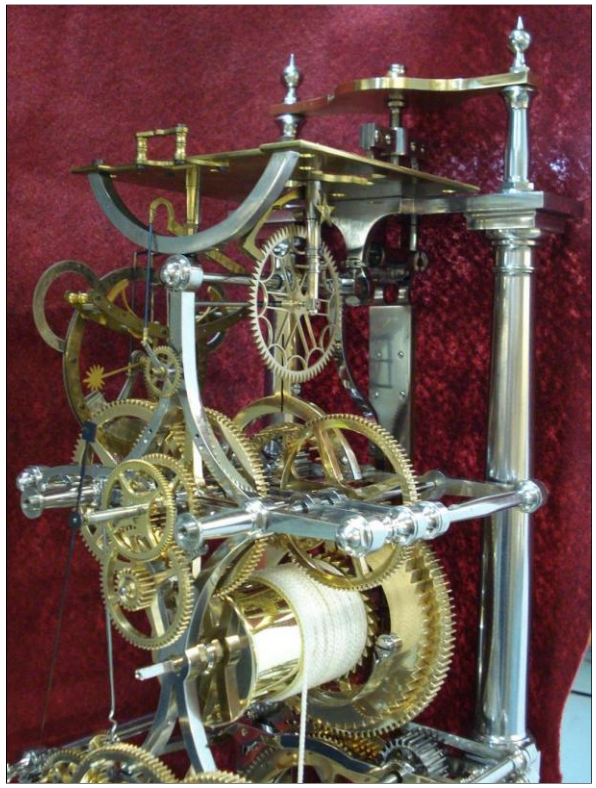


Figure 21. The restored step drive.

Figure 22. Tellurian by Zacharie Raingo, c. 1790

Figure 23. Wheel design copied by Pouvillon

Pouvillon did not think up the spoke design on his own. He drew his inspiration from a tellurian by Zacharie Raingo, c. 1790, to create his step wheel for the annual cam pack, (Figures 22, 23).

The cam pack is a major component which controlled several functions within the clock; it rotates once per year and contains several attached cams hence the name ‘annual cam pack’. It starts with a 73 toothed ratchet wheel which is driven off the strike train one tooth every five days giving one rotation in 365 days and is secured to an arbor that has an additional five cams. The first is an equation of time cam used to drive the glass mystery dial. The next two cams are used to drive two moveable shutters that indicate physically the rise and setting of a rotating sun which appears and disappears behind these shutters. The fourth drives a pair of dials that indicate the length of day and night respectively and the fifth is a snail cam to trip the Easter calculator once per year. So without this assembly, we lose five complications in the clock plus the seven complications within the Easter calculator.

The overall dimensions of the step wheel as well as the length of the arbor was determined by the existing ratchet drive and the extant pivot holes within the two drop down pillars as indicated by the arrows, (Figure 24). The remaining cams we were able to create through reverse engineering and the first four blank cams are shown edge on in figure 25. Note the blued angled levers are connected at the left to the various dial attachment points, red arrow, and are pivoted in the center; reaching upward toward the cam blank’s edges. With this existing arrangement we could use the method described next to create the proper cam profiles.

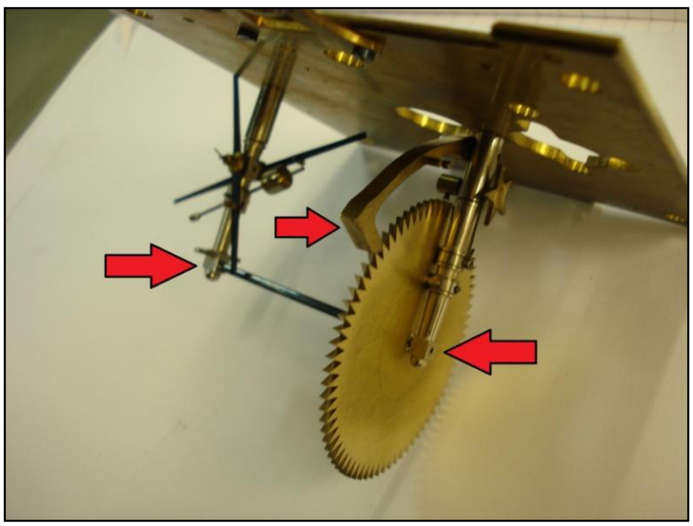


Figure 24. Blank of annual step wheel with arbor

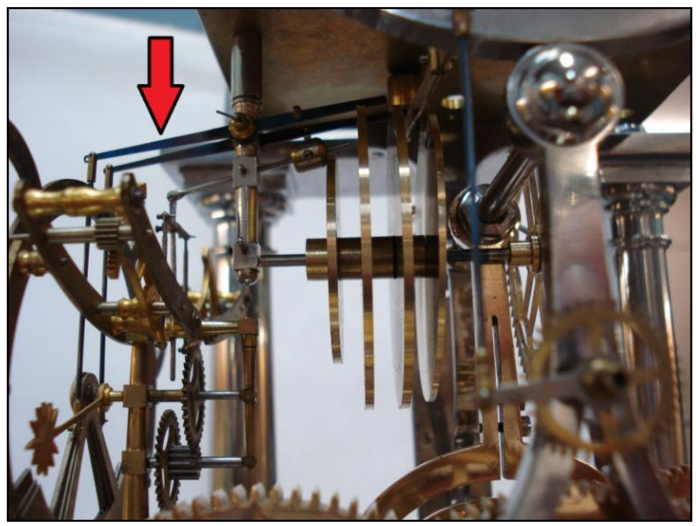


Figure 25. Four of five blank cams mounted to arbor

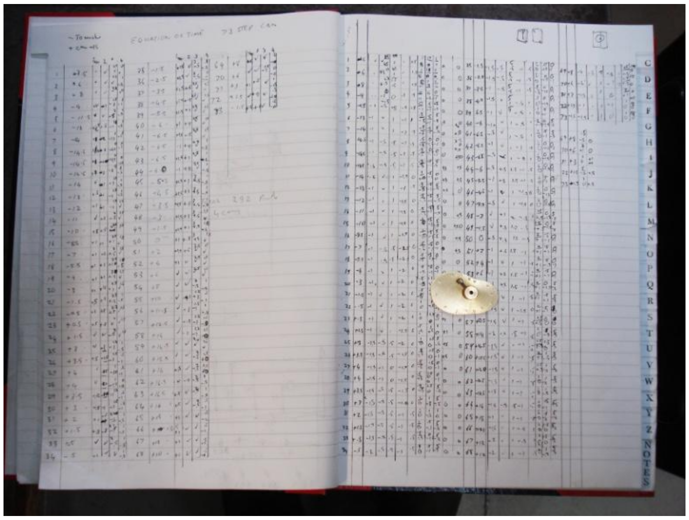


Figure 26. Log book showing meticulous position records

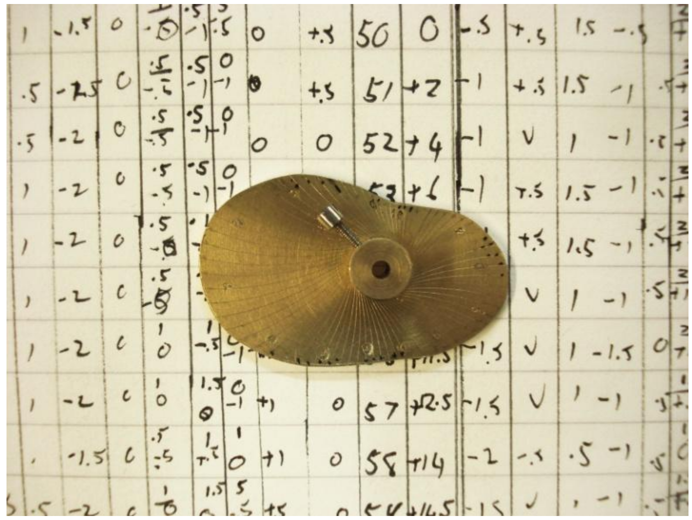


Figure 27. Equation cam with 73 adjustment scribe lines

We had all of the connecting levers from the point of the missing cams to their respective dials and so could calculate the cam position on the annual arbor and what the perimeter shape of each cam needed to be at every given point of the year to achieve the correct reading on the dials. This, however, is easier said than done. Figure 26 shows the error log book for the equation cam. In the first column are numbers 1 to 73; we have 73 stations corresponding to the 73 steps in the annual drive wheel. The next column is the amount of minutes the equation of time cam should lead or lag the mean time hand. And then in the third column we have the actual error or the difference between what the equation of time dial should read and what it actual reads. In other words these are the errors. On the cam blank you can see on each station a dot marked for each half-minute error, (Figure 27). So we have errors varying from approximately minus 1 ½ minutes to plus 1 ½, or about a three minute error. One only has the option of removing metal so we then convert these errors to all metal removal calculations and this is what's marked out on the cam. The exercise is then repeated to slowly narrow the amount of error and through this process the log book gets filled. The equation cam took eleven cycles of 73 iterations for each cycle, 803 separate operations. One can see how laborious this actually is. These logs show the methodical process and patience needed to compose the error tables used to create the correct cam profiles. And this method has to be repeated for four of the five cams in the cam pack, the trip snail excluded. It is a far more difficult proposition to make a cam fit an existing mechanism than to first create the cam and build the output dial reading from that cam. Please refer to the restoration sections of September and October 2011 on my web site to see in greater detail how these cams were created.

Figures 30 and 31 show the cam pack mounted within the movement. It's no accident that Pouvillon intended this part to have a prominent place within the upper, central part of the movement and made the front piece of the annual cam pack as decorative as he possibly could.


Figure 28. Cam pack components


Figure 29. Step wheel with assembled cam pack

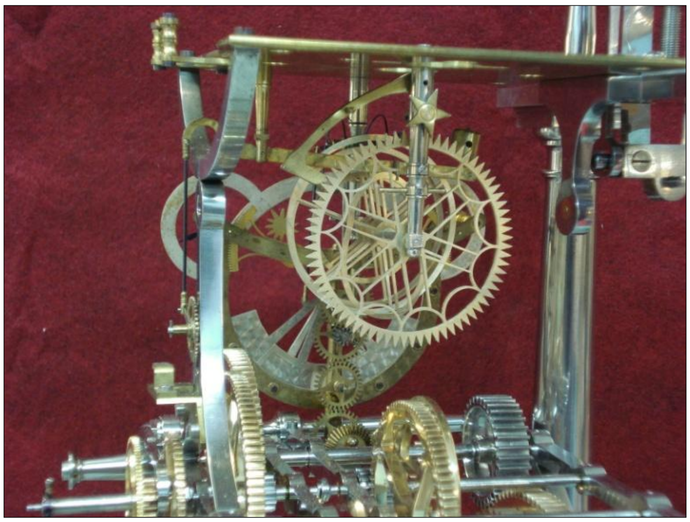


Figure 30. Annual cam pack, front view

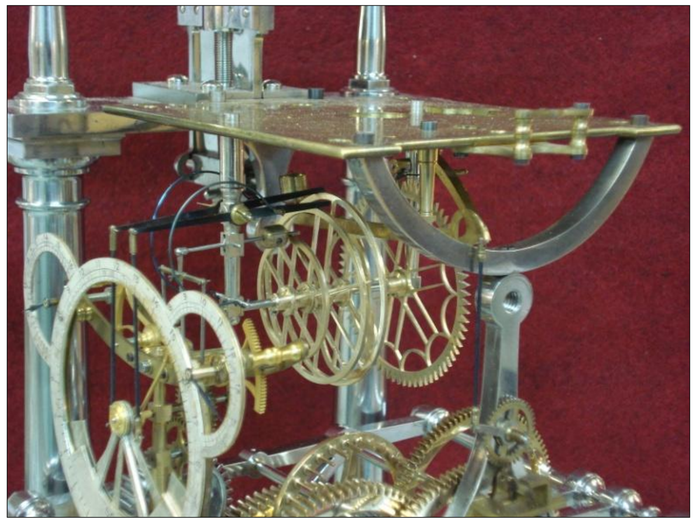


Figure 31. The annual cam pack, rear view.

Since the cam pack is a special and visually appealing part, one could see how it might have easily 'gone missing' during the time it was laying in pieces at the resale shop. We know from a photo in Antiquarian Horology which has an advertisement by a Paris clock dealer that the cam pack was missing from the clock from at least as far back as 1983.

6. **Restore missing planets within tellurian and orrery.** With the exception of the Earth, all of the planets and the Moon along with their connecting arms were missing. We had a photo of the clock with the original planets in place indicating that the planets were made of a white material, (figure 7a and b, page 6). Since these were made in the 1930's my guess would be that the white material would have been ivory rather than plastic. The primary concern was how to get the appropriate material. There is currently a ban on the trade of Ivory in the Western world. It turns out there appears to be a loophole for the United States as I was able to find a source that would only export to the US.[14] These were fairly small pieces so as to not be able to be used for large scale carvings, but large enough for our purposes. The stock available was in small bars called 'turning squares', (Figure 32). I chose one that was ½" square by 5" long as well as another that was 1"

square by three inches. The latter was needed to turn the handle for the main clock winding crank which I will include in this section since we are using the same material. A second, smaller handle was also made for the orrery demonstration winding crank, (Figure 38). Figures 33 and 34 shows the planet Saturn at about one centimeter in diameter. Figure 35 has the compliment of all eight planets for the orrery, excluding Earth and Moon which are in the tellurian. The different sizes are relative to each other and are not to scale. The variegated pattern and slight variations in color of this natural material makes ivory a good choice for this purpose. Figure 36 is a close up of the ball joint connection used to connect the wires from the individual planet to the orrery drive collet and is similar to what is seen in figure 7a and b.

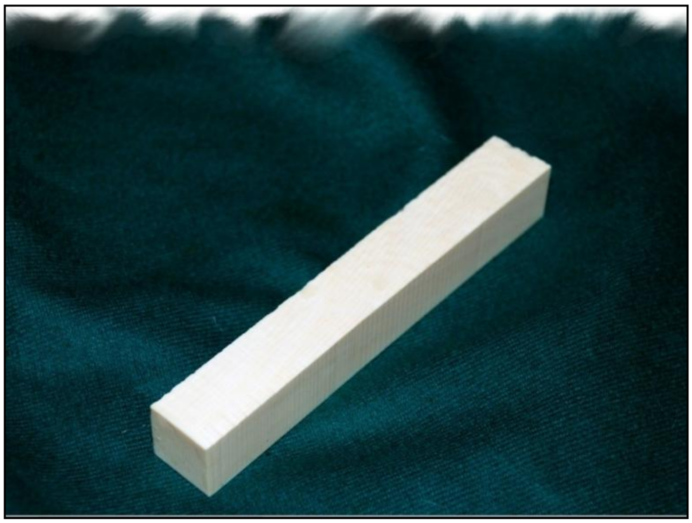


Figure 32. Example of raw, ivory turning block

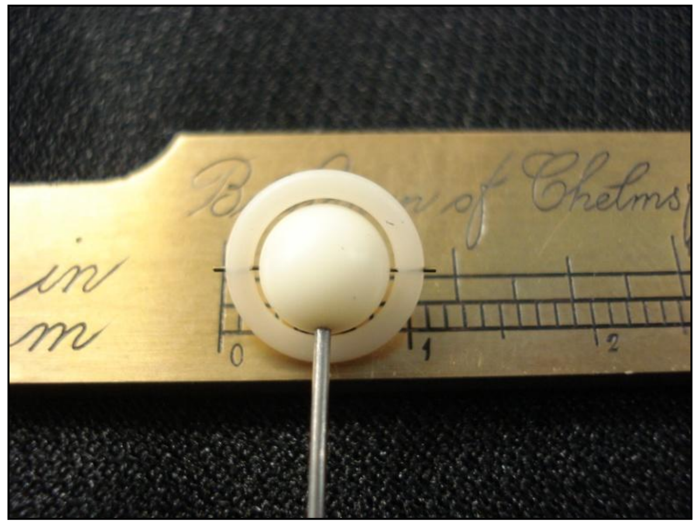


Figure 33. Close up of the planet Saturn at 1" in diameter

Figure 34. Three-quarter view of Saturn

Figure 35. Compliment of planets showing relative sizes

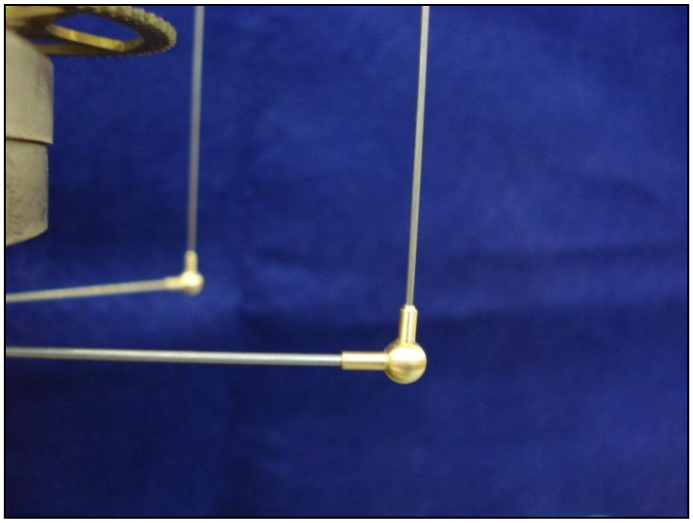


Figure 36. Close up of ball-joint for wire connection

Figure 37. Planets mounted to the tellurian and orrery

Figure 38. Close up of main clock and orrery ivory demonstration winding handles

7. Restore sunrise/sunset dial spiral bias springs, replace missing hand. The two dials indicating the times of sunrise and sunset mentioned in part five of this chapter was each missing their spiral bias springs. These looked similar to what the balance wheel hairspring would look like in a large pocket watch. They are needed to hold the dial hands in place to counter any inaccuracies due to lash between the dial pinion hand and its driving sector gear. Again, given the parameters of the needed function and the existing mounting points we are quite sure that a spiral is the type of spring originally used in this application. Indeed this type of spring fits perfectly on the dial hand arbor with the end of the spring being neatly pinned within an existing hole in a nearby pillar, (Figure 39, 40).

Figure 39. Spiral bias spring fitted to extant arbor

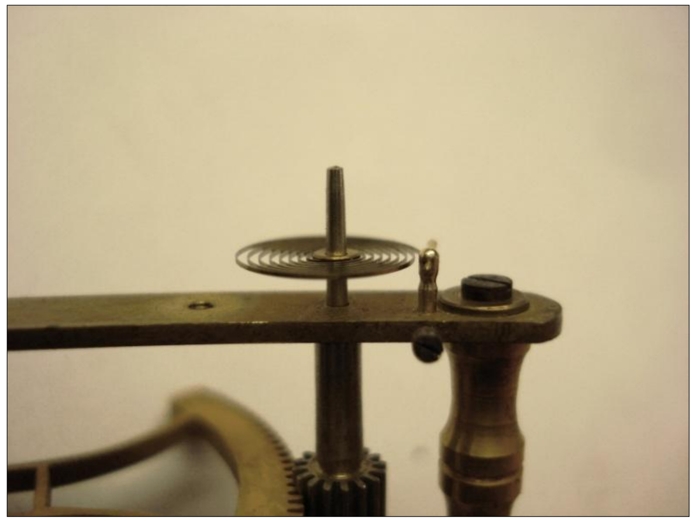


Figure 40. End of spring pinned to extant pillar hole

Figure 41. Spring steel as material for replacement hand

Figure 42. Replacement being hand filed to shape

One dial hand was also missing and a new one was made to match the existing one. Figure 41 shows a section of main spring steel used as blank material for this purpose. Figure 42 shows the traditional filing method used to fabricate the hand. On the next page is the completed hand, left, next to its mating original. Next is its installation along with the spiral bias springs within the sunrise/sunset dial network (Figures 43, 44).

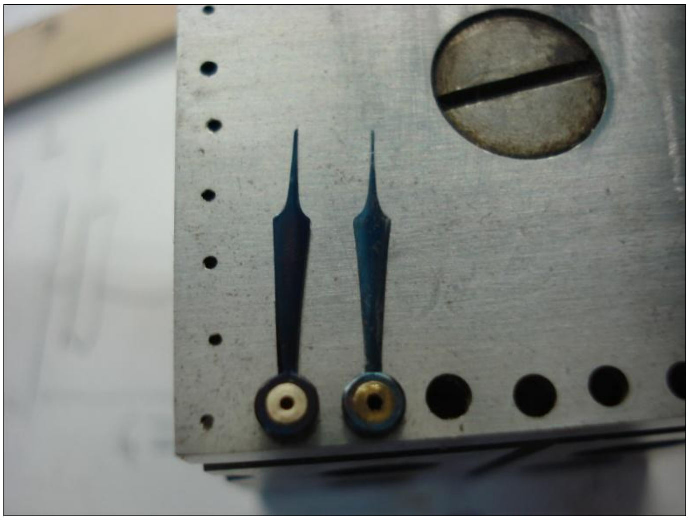


Figure 43. Recreated hand, left original mating hand, right

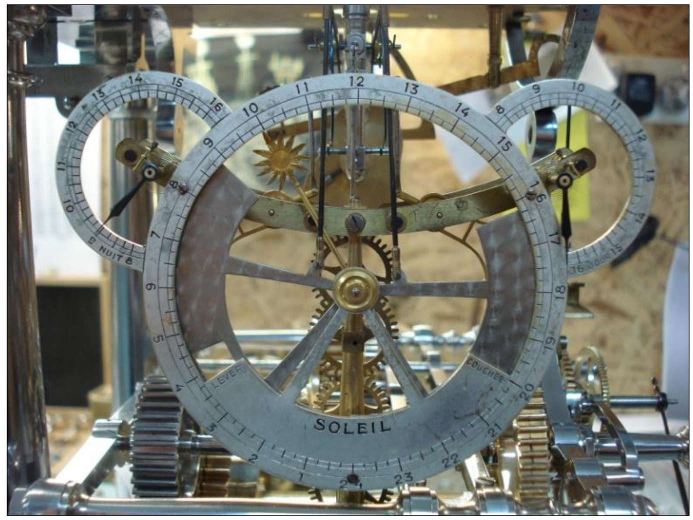


Figure 44. New hand and bias springs installed within dial

8. Restore sunrise/sunset shutter bias springs. The sunrise, sunset shutters also need bias springs to keep their respective cam follower arms engaged on the surface of the cams. Without these springs the weight of the shutters would pull the follower arms away from the cam surface. Here we had two ways to make a bias spring, each of which would have fit within the existing mounting points. The first is a conventional coil spring like what one would see in a retractable ball point pen and the second a 'C' shaped spring, arrow, figure 45. Either one works, but in my opinion the pair of blued 'C' springs look superior to what I think are cheap-looking coils. Without any historical evidence to guide us I had to make a judgment call on this one. If we later discover that a different style of spring was actually used, a change out is easily made. Figure 46 shows the cams in place and one can see how the weight of the shutters downward pull must be overcome with a set of bias springs. Note how Pouvillon approached this same issue, but in a different way with the lever shown touching the small cam in the foreground, figure 45. Here he uses a weight to counter balance the bias springs installed for the two dial hands to indicate the sun's rising and setting times. Why not do the same for the other levers? My guess is that since the weight of the shutters is considerable, it would have required a large weight to match the spring, but primarily I think he simply wanted to do this one differently.

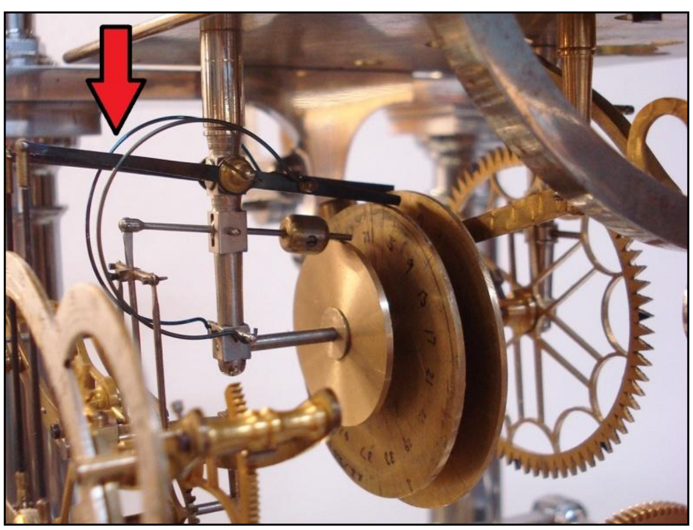


Figure 45. Pair of 'C' springs to bias sunrise/set shutters

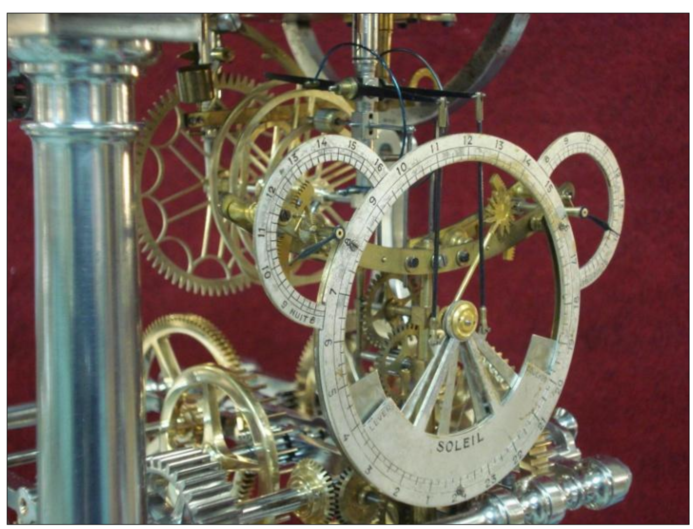


Figure 46. Bias springs in place holding levers to cam surface

9. Repairs to the Easter calculator.

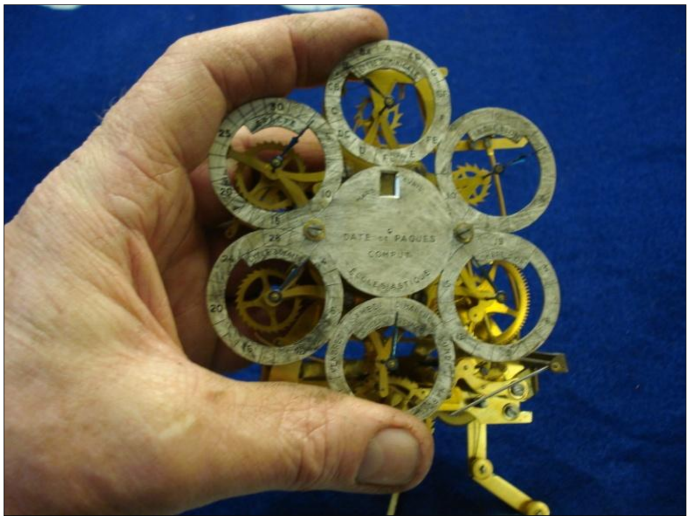


Figure 47. The Easter calculator mechanism

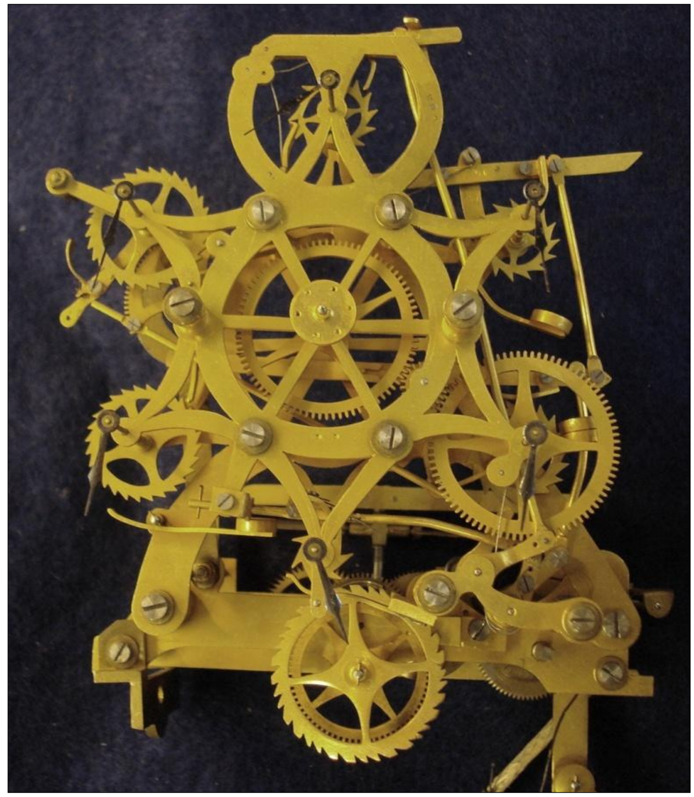


Figure 48. Calculator with dial removed

I now turn to the Easter calculator. Here there were multiple issues. At this point in the project we had to examine and explore how the Easter calculator was originally made, and consider the changes that occurred after Pouvillon's death; the missing parts and the tortured additions from later persons who did not understand its design. We had to go through many thought exercises to correct the prior alterations done, re-create missing components and restore to proper functioning this very complex sub-system of the clock. A brief explanation of the dial work of the Easter calculator is given in Appendix A and a more detailed examination as to how Easter is calculated from Catholic ecclesiastical tables is available on my website.

The restoration efforts divide into two categories. First was the removal of later, faulty parts installed by persons other than Pouvillon as evidenced by the fact that they could not function correctly as installed, or they were in conflict with the obviously intended design or were clearly made by a different hand. The second category and this was the most difficult, was the design and replacement of missing parts in the manner Pouvillon would have originally intended.

A. Restore calculator's automatic annual trip linkage from cam pack to calculator. Sometime in the past a previous repairer had tried to figure out how to trip the Easter calculator. This had probably occurred after the annual cam pack, described previously, went missing. Without this part the calculator could not function as intended. Someone had installed a lever that was tripped by a pin driven into the face of the strike train main wheel and linked this to the Epact ratchet wheel trip lever within the calculator directly above. This pin was of a different material and longer than the prior pins which were used in the clock as a count wheel, (Figure 49). The pin used to trip this lever is clearly something that was added to the strike wheel at a later

date and would have tripped the Epact dial once every day, the same period as the strike train wheel rotates. This makes no sense since the Epact is a once per year indication. It is the age of the moon on January 1st and so the dial is demarked from 1 through 30. Simply feeding the Epact dial once per day would not have activated the rest of the calculator in any event. Furthermore, the lever and its clevis looked to be something factory-made and what one would have seen in a contemporary radio controlled model, and not from the time or in the manner Pouvillon would have made these parts, (Figures 50, 51). Therefore this linkage was removed. One may inquire why such an attachment point on the Epact ratchet was available if it were not meant to have some type of lever attached to it, (Figure 52). We will answer this in section C.

Figure 49. Epact trip lever driven off strike train wheel

Figure 50. Detail of the trip lever from the other side

Figure 51. 'Off the shelf' clevis of obviously much later date

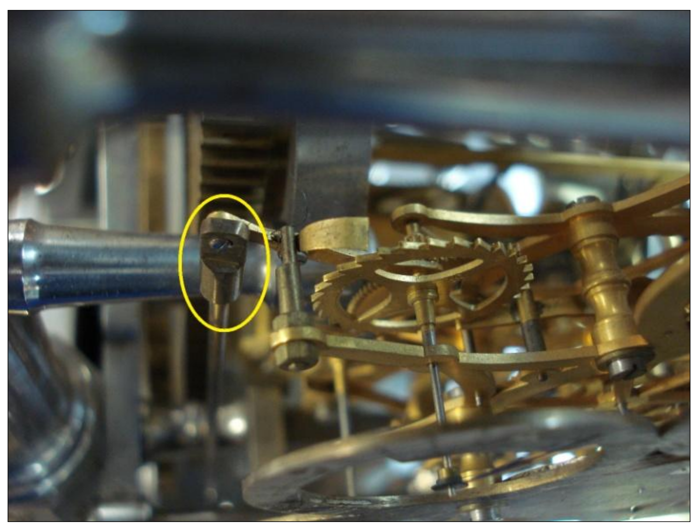


Figure 52. Upper end of lever on to Epact attachment point

Perhaps realizing that the linkage described above would not trip the calculator, or more likely a later person, had also decided to try his hand at activating the calculator but could not figure out how to do this automatically from the clock mechanism, and so installed a crudely-made manual trip lever. This too was removed, (Figure 53, 54).

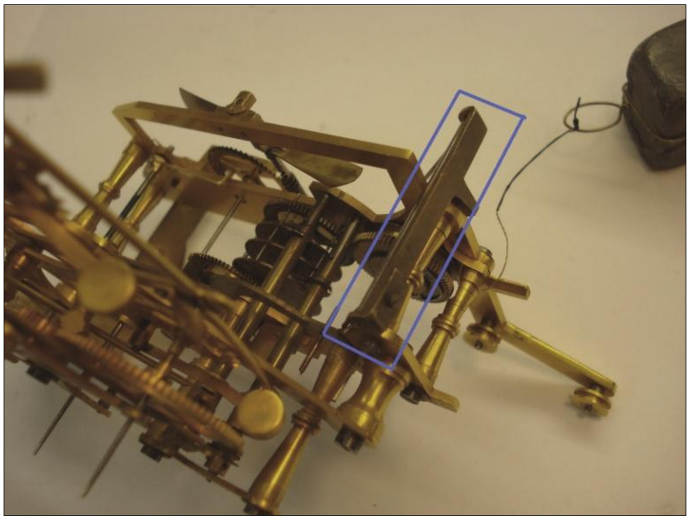


Figure 53. Manual trip lever of later manufacture

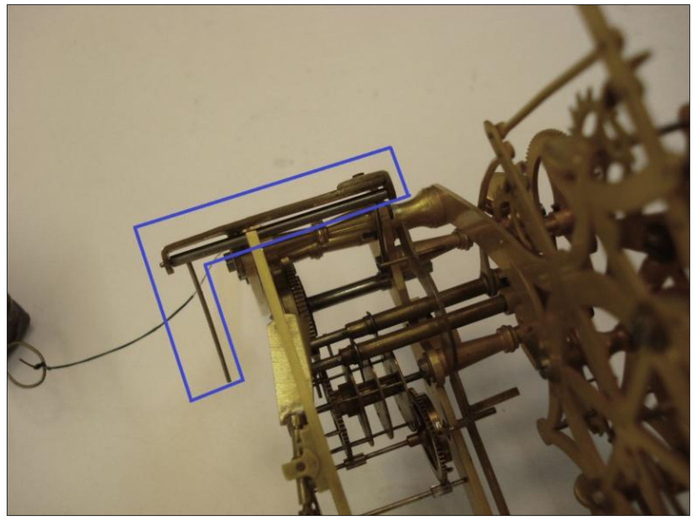


Figure 54. Another view of the later trip lever

Now that extraneous parts to the calculator had been removed we next examined the clock and calculator to see how they would have been connected to enable the calculator to be tripped automatically once per year. The fifth cam on the annual cam pack, the snail which is depicted in the upper left hand corner of figure 28, page 18 is located exactly above the area on the calculator where a drop linkage should connect to that area within the Easter calculator and where the trip must be located.

First we restore a lever linkage connected to the fifth cam, the snail trip cam. Riding on this cam is a lever which will be tripped once per year. We cannot know exactly how Pouvillon would have made this lever appear absent original photographs but we are confident that the Easter calculator would have been actuated from this location given the existing lever pivot mounting points on the extant drop down bracket, the space on the annular cam pack for the trip snail and the fact it is in the correct alignment from this cam to the Easter calculator's trip lever location directly below, (Figures 55, 56). We studied the adjacent lever Pouvillon made for the equation of time function and made this lever and clevis in the same style and damascene finish, (Figures 57, 58).

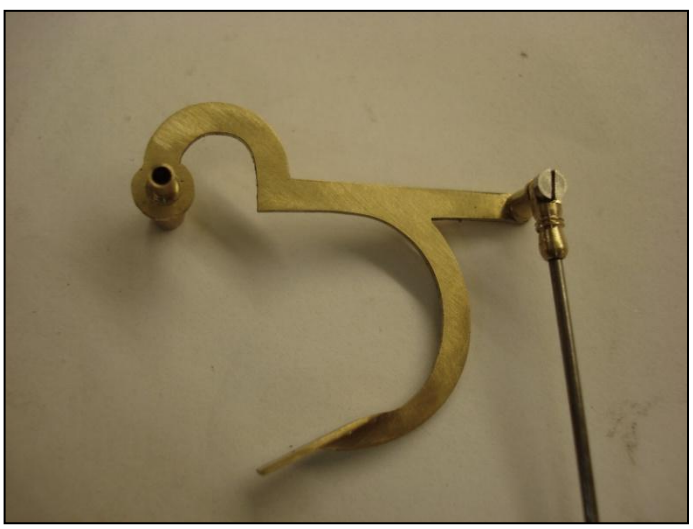


Figure 55. Trip lever which operates off the snail cam

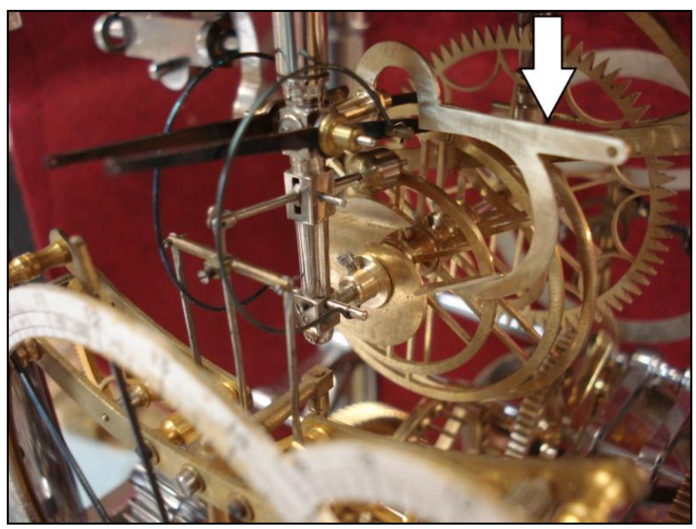


Figure 56. Trip lever in place on drop down pillar

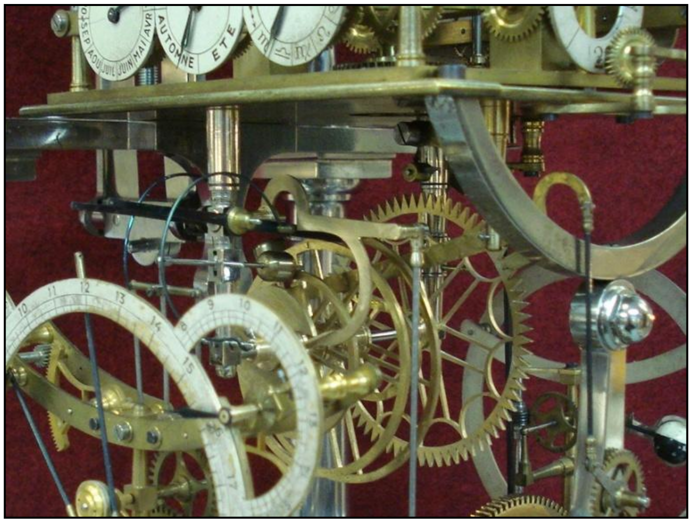


Figure 57. Trip lever compared to extant equation lever

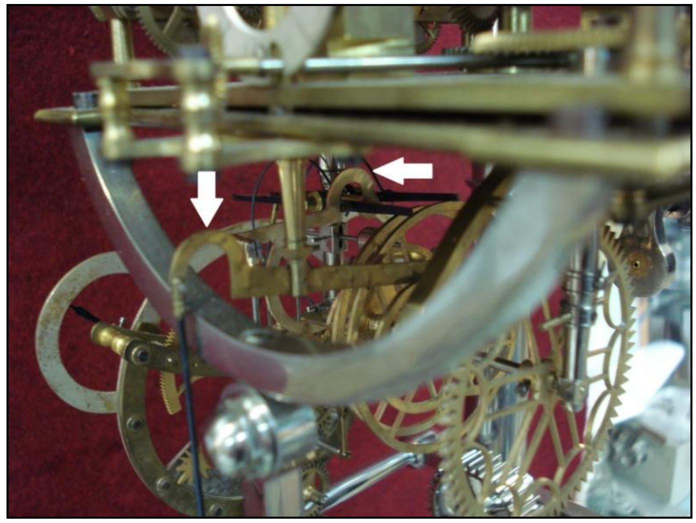


Figure 58. Equation lever, foreground, trip lever background

B. Restore the trip mechanism within the calculator. This system is needed to properly initiate the calculator's computation cycle. Part of it was incomplete. The way the calculator is tripped is similar to that used in a conventional strike train. There is a lever that drops to block a detent pin on a wheel in the drive train for the calculator, (Figure 59). An additional lever is mounted to the same arbor as the warning lever, loosely, but connected in such as way as to lift the warning lever as it also is raised by the snail cam's contour throughout the year since that cam is part of the annual cam pack, (Figure 60). At a point slightly before the edge of the snail, the warning lever is raised enough for it to clear the calculator's drive train wheel detent pin and the wheel is released. It, however, makes only one revolution because that pin then contacts a protruding face on the warning lever – again very much like the conventional warning in a strike sequence. When the trip lever drops off the face of the snail on January 1st, it allows the warning lever to fall and releases the drive train to power the calculator through its approximately 30 second sequence of events to calculate the date of Easter. Upon completion of the calculation the warning lever re-engages the detent on the drive train wheel, locking the train until the following year. The calculator is powered by a small weight, apart from the rest of the clock.

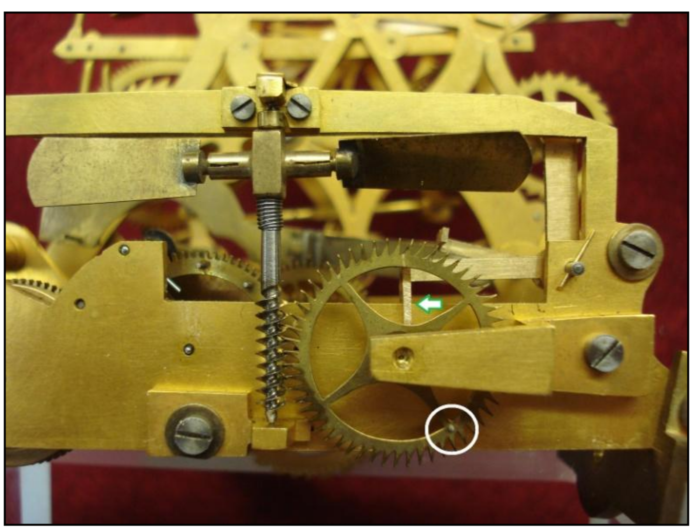


Figure 59. Extant detent pin on wheel and its trip lever

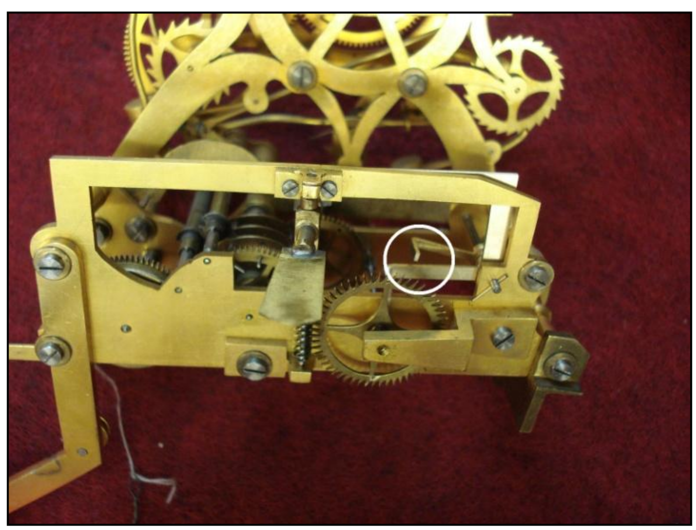


Figure 60. Restored warning lever

We had ample evidence that such levers existed not only from the fact that they necessary for the calculator to work, but also witness marks on the arbor which indicated that parts were mounted to an area where the bluing was missing. The position of the drive wheel's detent pin dictates how long the warning lever must be, (Figure 61). The area where the witness marks showed prior mounting points were neatly filled with the collets for the restored warning and trip levers, (Figure 62).

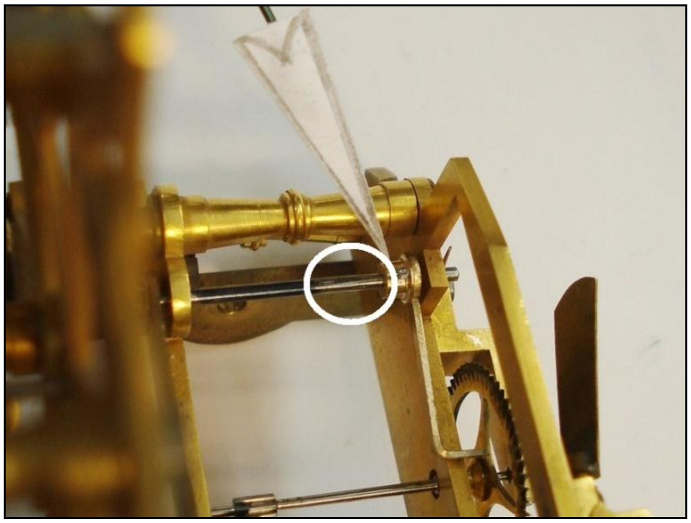


Figure 61. Arbor showing empty area for missing parts

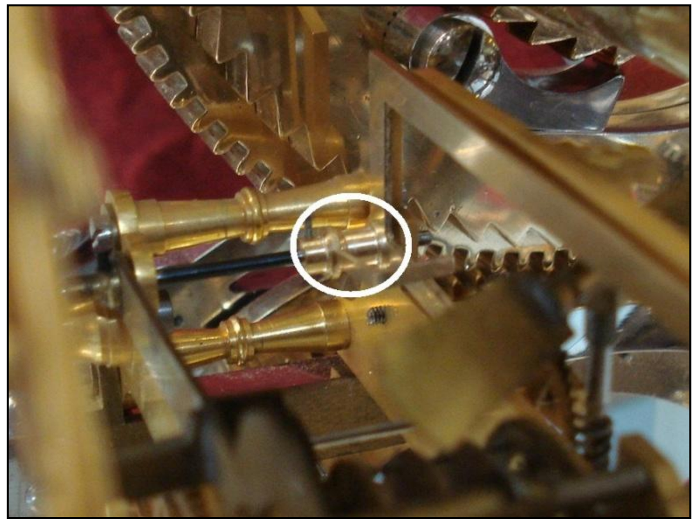


Figure 62. Empty area neatly filled with two lever collets

We chose the square shape for the trip lever since it is the most inconspicuous, and tucks nicely behind the existing rectangular frame bracket, (Figures 60, 62). Without historical photos there is no way to know how Pouvillon would have made this look and it could have taken any variety of shapes. This is in contrast to the annual cam pack, where we had some historical evidence to go by and a clearly defined environment from which to reverse-engineer our parts thus giving us a firm idea of what those parts should look like. With the Easter calculator levers, we can only guess at the best possible shapes. We do not doubt their necessity to carry out their intended functions nor are the parts functionally different from Pouvillon's original design.

It is very likely that these missing parts and the lost linkage to the missing cam pack prevented anyone who was not highly conversant with the functioning of the calculator and the overall design of the clock from understanding how to restore the mechanism's automatic annual trip function and so they resorted to the improvised manual trip lever and miss-connection from the strike main wheel to the Epact dial.

<u>C. Restore the calculator's perpetual function</u>. Pouvillon refers to his having created a perpetual ability to the mechanism in two newspaper articles we have dating from 1953[8] and 1955[12]. So while we know the calculator was substantially completed by 1946 as indicated from the year stamped on the Easter date disc, Pouvillon was still making changes until at least 1954 when he would have been 76 years old.

As reviewed earlier, the Epact function was not automatically adjusted and in fact was miss-connected to the strike wheel. This dial has 30 divisions representing the phase of the moon on January 1st. The lunar cycle has a period of 19 years, after which the phases of the moon again fall on approximately the same dates in the solar year, but not exactly. The tropical year is about 365¼ days, while the synodic month is also slightly longer than 29½ days on average. So after 19 years the epact must be corrected by +1 in order for the cycle to repeat over 19 years.

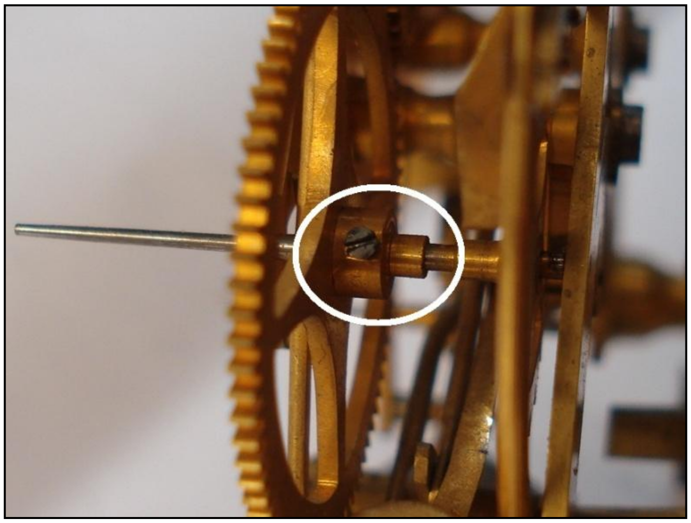
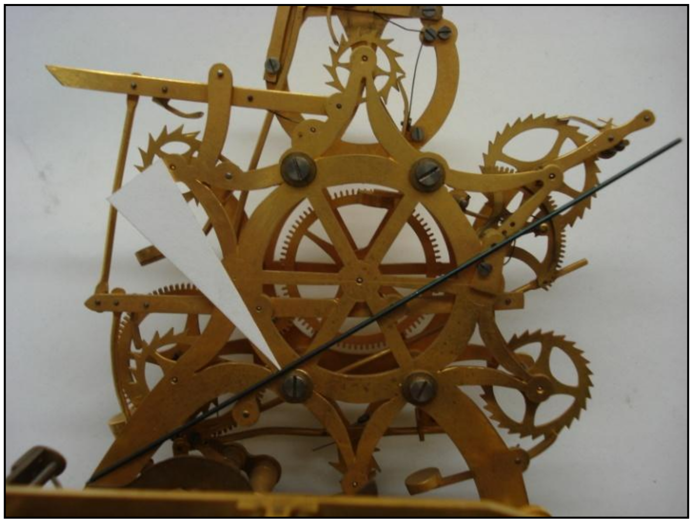


Figure 63. Golden Number drive wheel with open shoulder **Figure 64. Epact 19 year correction cam.**

There is another dial on the calculator called the Golden Number which indicates the number of the year in the lunar cycle and conveniently, it has 19 divisions and it rotates once in 19 years. In addition, a careful review of the dial output arbor in this part of the calculator reveals an unused shoulder on the drive wheel where it appears there was a mounting point for another component, (Figure 63). We restored what we believe was Pouvillon's solution to the perpetual epact by designing a cam fitted and mounted to this location, (Figure 64).

We then restore a connecting rod that rides upon this cam and runs diagonally across the interior of the calculator from the lower left hand corner where the Golden Number mechanism is located to the upper right hand corner where the Epact dial is located. As seen from the rear of the calculator, the rod is shown in front of the movement plate for illustrative purposes only, (Figure 65). Further strengthening our argument for this restoration is the fact that this rod runs very near one of the plate pillars and this pillar is cut out with a flattened spot in precisely the area that rod passes nearby, as indicated by the arrow in figure 65 with the cutout shown in figure 66. This cam provides a correction to the Epact dial to make the Easter calculator a perpetual calculator for 400 years or until we have a missed leap year. This perpetual function only applies only to the six dials that ring the center Easter date indicator and not the center dial itself. That dial is only good for 19 years.



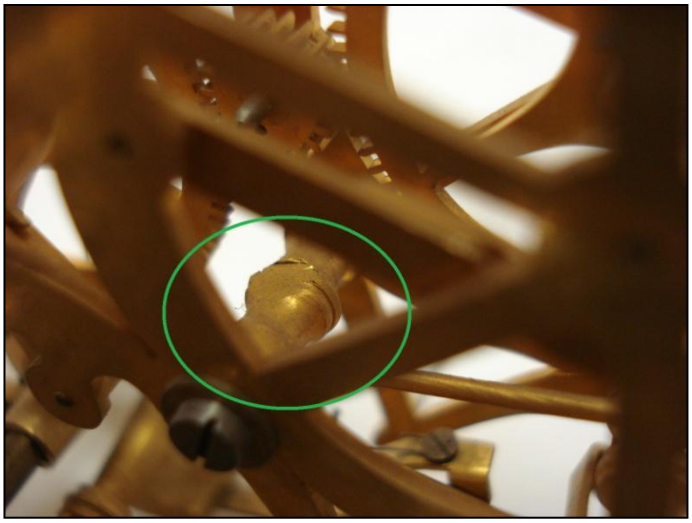
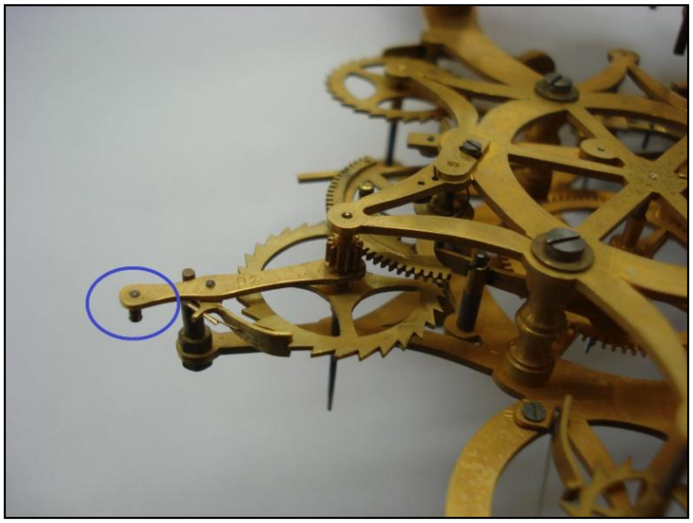


Figure 65. Proposed linkage from Golden Number to Epact **Figure 66. Close up of pillar allowing for proposed linkage**

Figure 67 shows the attachment point for the Epact correction. This is the same point where someone had erroneously tried to connect the Epact dial to a once per day input from the strike train main wheel, (Figure 52, page 34). Next we created a cantilever at the other end of the rod to engage the ratchet and give it a push by one tooth every nineteen years, (Figure 68).



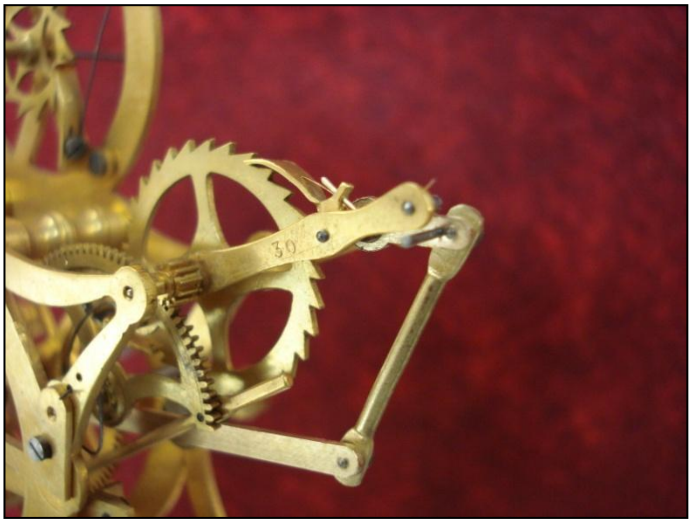


Figure 67. Extant point of contact for Epact correction **Figure 68. Cantilever from restored lever to Epact point**

<u>D. Replace missing calculator drive chain and weight</u>. This was a minor restoration. The calculator uses a small, separate weight driven power source apart from that of the clock itself. It was obvious the auxiliary weight present was a later addition as it was simple piece of scrap metal. The weight line was missing. A careful examination of the winding drum and pulley system for the calculator revealed that these had a flat-bottomed profile with even-spaced 'nicking' on the surface indicating that a chain similar to that of a watch fusee chain was used. Furthermore, there is an attachment point identical to what one would find on a fusee barrel to receive a chain hook. We remade the weight and created an extra long chain needed for this application from several old watch fusee chains, (Figure 69). Figure 70 shows the pulley guides that direct the chain from the winding barrel to a hole in the base of the clock platform. The Easter calculator weight hangs in the wood base along with the other weights.

Figure 69. Weight and chain for the Easter calculator

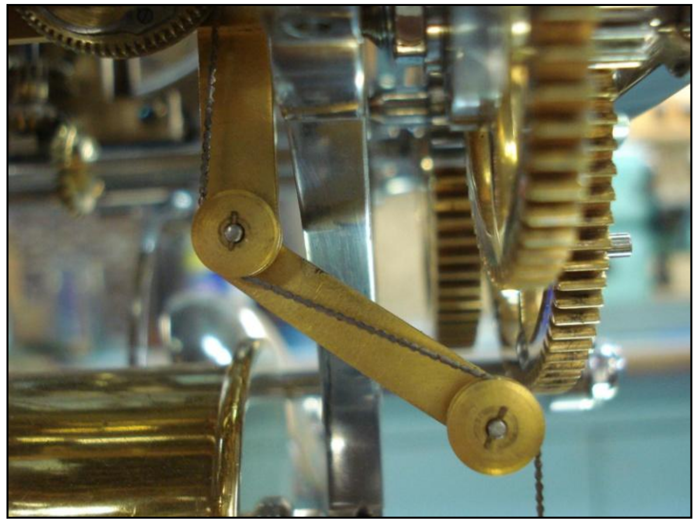


Figure 70. Pulley guides for the Easter calculator

10. <u>Restore the tellurian/orrery demonstration crank</u>. Pouvillon had created this clock as an advertisement for his skills and displayed this clock in many places over a long period of time throughout France for which he received several awards. The clock as received had no demonstration function for the tellurian/orrery complications. We thought this odd as this would be an obvious ‘selling point’ for Pouvillon to impress his audience. Again we looked to the artifact for some witness marks and found these on the lower plate of the superstructure holding the planetary complications. It is a bit more involved than a simple crank to the

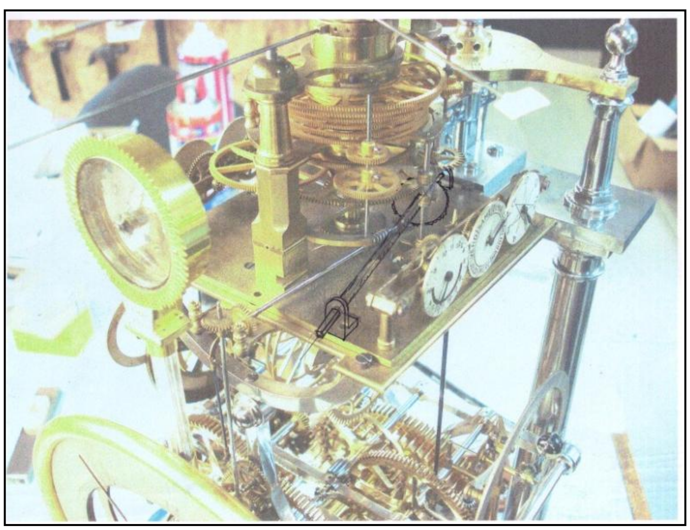


Figure 71. Rendering for demonstration crank

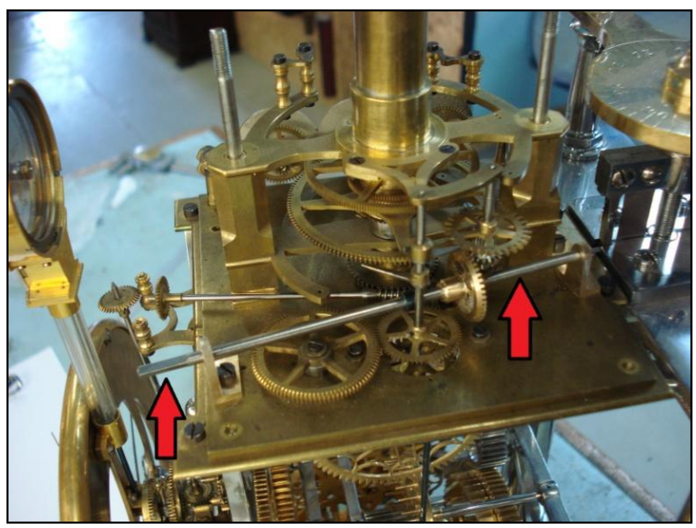


Figure 72. Tellurian/orrery demonstration crank

mechanism since the planetary functions are normally in a locked position with respect to its drive, within the strike train. However, that lock is merely a spring-loaded detent. So we designed the crank to slightly slide backward when the winding key is inserted and this disconnects the detent lock; allowing the celestial systems to be demonstrated in forward or reverse, (Figure 72).

Figure 71 shows a pictorial device Buchanan has used in many areas of another astronomical commission clock he is currently building for me. When we are trying to visualize what a prospective part should look like within the context of an existing background, he takes a photo, bleaches it digitally so as to make his drawing

of the proposed part show more clearly to the viewer, and then draws the part onto the bleached photo for review and comments.

11. Restore zodiac precession complication. I now turn to the restoration of the first of two major complications within the tellurian, the precession of the zodiac, sometimes referred to as *the slowest hand on the celestial clock.* A full discussion of this function is explained on my website, but briefly it is the apparent shift in the location of the stars in the sky in relation to local time and is due to the circular 'wobble' of the earth on its axis; very much like that seen on a spinning gyroscope which is set upon its end. But in the case of our planet, the wobble's axis is at the Earth's center, so both of the poles exhibit this behavior; counterclockwise for the North pole and clockwise for the South pole. It takes nearly 26,000 years for the Earth's axis to make one complete circuit. Therefore the twelve houses of the zodiac will shift by one complete house in 25,806 years/12 houses or one every 2,150 years. Astrology had its beginnings in Babylonia about 2000 BC. So since that time the stars have shifted by nearly two complete houses. All of which begs the question of the value of astrology and the popular belief in human characteristics being attributed to the astrological sign one was born under. So the next time you're at that tacky bar and someone asks you your sign, the appropriate response might be 'It all depends, which millennium were you thinking of?'

The precession function is depicted by the moveable lower silvered band surrounding the tellurian and having the signs of the zodiac engraved on its surface. Pouvillon had described this in an interview for a Paris newspaper in 1953 and the function was also described by Mr. Bernard Miclet in his article published in the French antiquarian horological publication, Bulletin of A.N.C.A.H.A.[1] Both of these sources were very specific about the existence and function of this complication in that the lower silver band, surrounding the tellurian mechanism and depicting the twelve signs of the zodiac, rotated once in 25,806 years to mimic the zodiac precession and that Pouvillon had achieved this through the use of "twelve wheels and twelve pinions". The upper silvered band is fixed and is marked in 360 degrees making the comparison between the two obvious. This upper graduated ring is also used to track the annual movement of the tellurian mechanism as it rotates with the Earth / Moon system allowing one to track the Sun's yearly apparent motion through the zodiac. During an average lifetime of 80 years the lower ring will move relative to the fixed upper ring by the width of a pencil line, 0.0487" or 0.052cm.

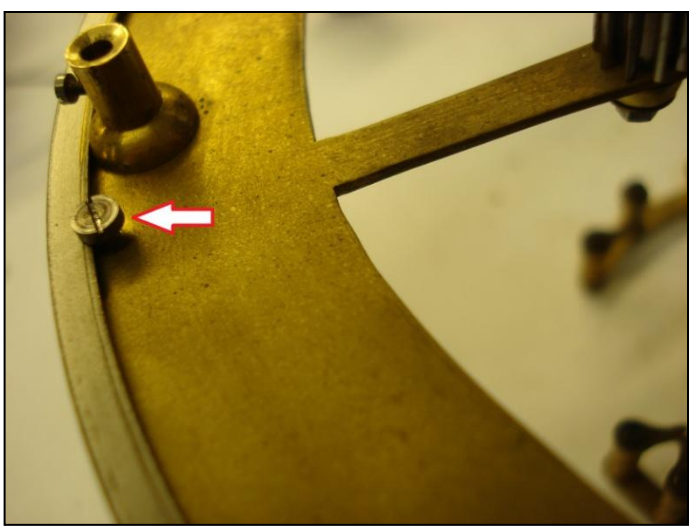


Figure 73. Bearing point for rotating zodiac ring

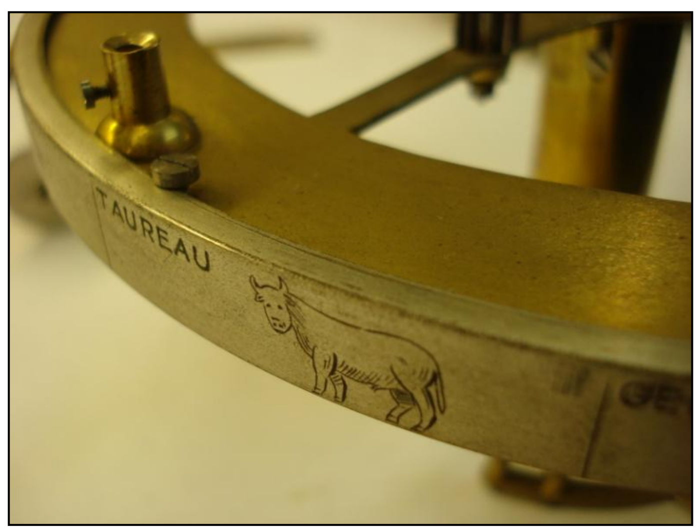


Figure 74. Zodiac ring with one of three bearing points

As found, the zodiac ring was clearly mounted in such a way as to be moveable. The ring is held slightly loosely between three bearing points, (Figures 73, 74). However, all evidence of the mechanism to achieve the very long rotational period was missing. There were no wheels, no obvious mounting points for these wheels or plates or where these mounting points could have been located. All we had were a few empty holes in the bottom of the tellurian dial support structure. So the question now becomes, was this complication ever built or did Pouvillon engage in a bit of puffery? Did Mr. Miclet, since deceased, really observe this complication in 1985 or did he simply take the information given in the interview for the Paris newspaper in 1953 as fact and repeat this in his article? We decided to reinstate this complication with the proviso that any work we performed was fully reversible with no alterations to the original artifact. Also the complication would be made in such a way as to be invisible to anyone who had taken any of the photos we have up to this point so as to not conflict with the pictorial historical evidence we have to date. We also made sure that the complication conformed to the “twelve wheels and twelve pinions” asserted by Pouvillon. It turns out that this combination mathematically results in a surprisingly simple set of wheels using common tooth counts as indicated in the formula below; with the first eight wheels being identical. The twelve wheels and pinions are shown in the drawing planted within the tellurian perimeter in figure 75, and the blanks in figure 76.

$$\frac{48 \ x \ 48 \ x \ 48 \ x \ 48 \ x \ 48 \ x \ 48 \ x \ 48 \ x \ 48 \ x \ 46 \ x \ 44 \ x \ 34 \ x \ 24}{24 \ x \ 24 \ x \ 24 \ x \ 24 \ x \ 24 \ x \ 24 \ x \ 24 \ x \ 24 \ x \ 20 \ x \ 20 \ x \ 16 \ x \ 16} = \frac{412896}{100} = 4128.96$$

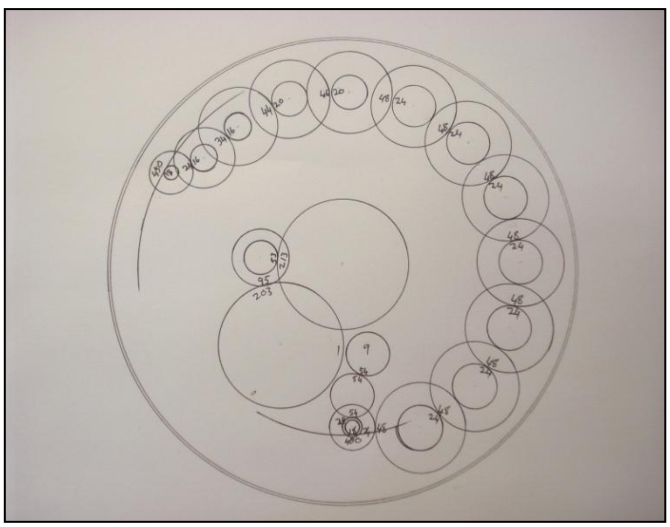


Figure 75. Wheel layout using Pouvillon’s description

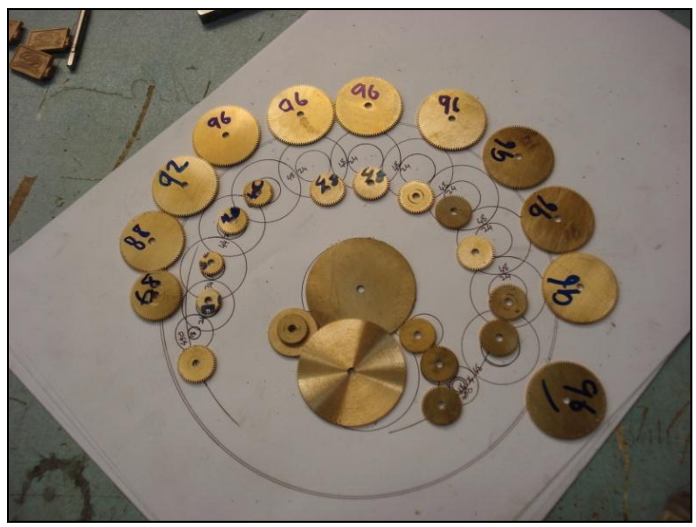


Figure 76. Brass blanks for the zodiac precession

We begin with the gear that will drive the lower zodiac band. This consists of a thin ring gear with a diameter of five inches and an internal tooth count of 450. We made two of these; the second to be used in the next complication. Figure 77, shows the internal teeth being cut. Figure 78 shows the rough wheels mounted to the as yet, unfretted frame.

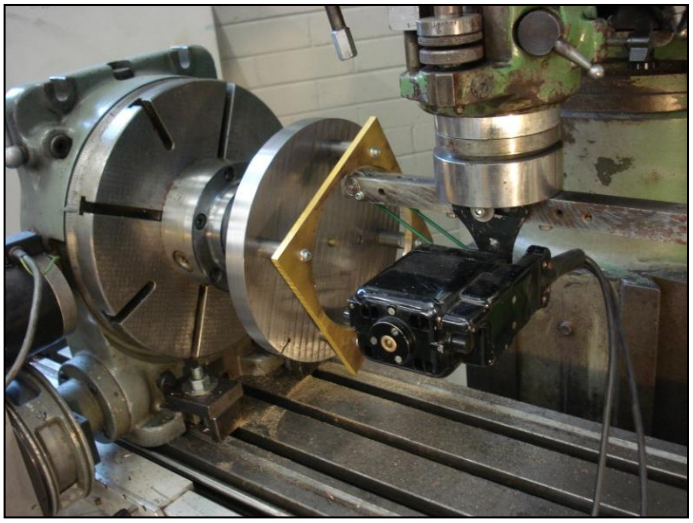


Figure 77. Cutting the 450 internal teeth on a 5” ring. **Figure 78. Blank wheels and frame in position**

In figure 79 the wheel works are finished off as well as the frame cut out to mirror exactly the existing tellurian base frame and are sandwiched to that frame, (Figure 80). It is held to the original frame using the existing empty holes in the frame.

The power input is taken from Mars, the uppermost planet arm nearest to the underside of the tellurian structure where all of the zodiac precession mechanisms are tucked away, white circled areas, (Figure 87, page 46). Its orbit is 687 days. A careful look at one historical photo we have of the clock does indicate an attachment point from Mars to the tellurian’s undercarriage. So we believe we are correct in our design. The next three wheels bring the rotational period back to one rotation per year. The pin on this annual wheel will click a ratchet once per year and through the next three wheels we come to the input wheel for the zodiacal precession train at ¼ turn per year. Therefore 4128.96/4 = 1032.24 for the output pinion to the ring gear. That pinion of 18 leaves turns 25 times for each rotation of the 450 toothed ring bringing the total to 1032.24 x 25 = 25,806 for the number of years to complete one rotation of the zodiac ring. When viewed from all angles except from directly above and even here it takes some effort, the restoration is invisible, (Figure 91, page 49).

Figure 79. Cut out frame sandwiched onto original frame **Figure 80. Original tellurian frame**

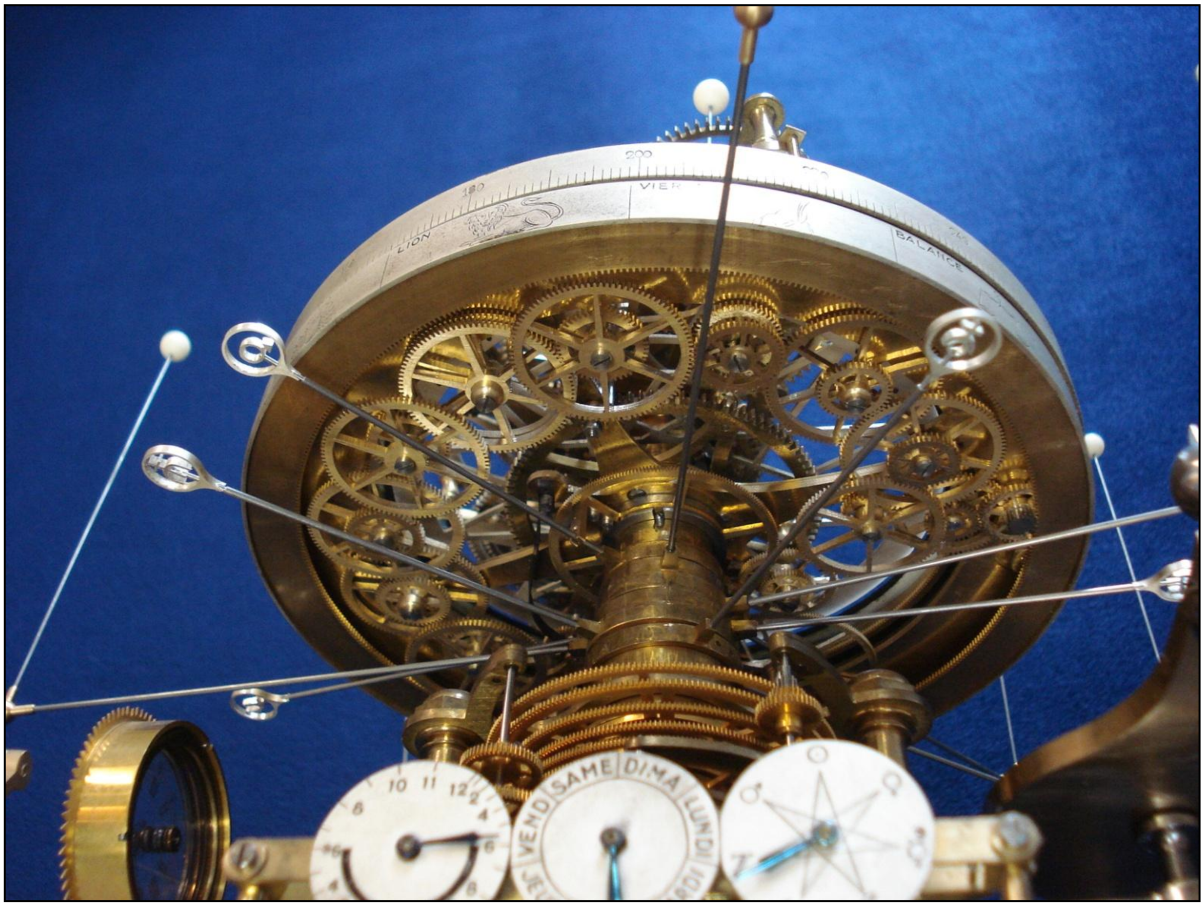


Figure 81. View from the underside of the tellurian

However, if one takes a look directly from below the tellurian deck, the new wheel work is beautifully displayed! Figure 81.

<u>12. Restore annual year indication</u>. The enamel tellurian dial originally had a square aperture in the January sector which was used in the display of the year using the last two digits. We have ample photographic data of an identical tellurian dial having this same aperture, (Figure 16, page 16). The dial as well as many of the tellurian components was not created by Pouvillon.[10] We have evidence that the dial was made about 1790 and another, identical example had a removable second digit to make the dial useable when the century turned from the 1700’s to the 1800’s and so needed to have the second digit in the year changeable from ‘7’ to 8’. The dial has the first digit of the year permanently fired onto the surface, with the remaining two visible through the aperture indicating 00-99.

As received the aperture on the dial was closed with a white filler material, (Figures 82, 83). Here we begin to get into some pure speculation. On the one hand Pouvillon was anxious to have as many complications as could pack into his clock. Moreover, this indication was not repeated anywhere else within the movement and if Pouvillon received the tellurian structure intact, it should have had this complication already present and ready to go. He would have had every incentive to use it. On the other hand, what if the tellurian was not complete and we presume that the year date ring and maybe the associated driver were missing? In this case Pouvillon may have taken the easy way out and simply dispensed with the effort to recreate this complication

and covered up the aperture. We do know after the fact that creating this ring took quite a bit of time and skill; surely Pouvillon had the skills but we do not know if he actually did it, (Figure 84). Of course a third alternative could be that this complication was lost as were many other parts during events after Mr. Pouvillon's passing and the aperture then closed up. Unfortunately we have no historical photographs that show this area with enough clarity for us to make the proper determination.

Figure 82. Filled in square aperture from the front.

Figure 83. Filler used to seal aperture, dial underside.

Figure 84. The 450 internal toothed ring gear for the years

Figure 85. Other side of the ring gear has 00-99 engraved

To be honest, if we had not decided to restore the zodiac precession I would have assumed Pouvillon had taken the second course and left the aperture covered. But, since I was confident that Pouvillon did make the zodiac precession and we had now restored the drive to the zodiac precession ring it was a straight forward job to extend this drive to the annual date ring as well, see schematic page 76. Both rings employed the same internal 450 tooth counts. It also returned what is a fairly important piece of information not duplicated elsewhere within the overall context of the clock and removed what seemed to be evidence either of a shortcut or effort to conceal the loss of parts.

The input wheel we used to drive the twelve wheel zodiac precession train was also used to turn the year date ring. That ring has 100 divisions from 00 through 99 engraved on its surface and so turns once every 100 years, (Figure 85). As with the ring gear driving the zodiac silvered band, this ring gear also has an internal tooth count of 450. So with a drive pinion of 18 leaves turning ¼ turn per year on the 450 toothed ring gear we have 450/18 x 4 = 100 years for one rotation of the year date ring. Figure 86 shows a simple temporary '9' for the second digit. This is the same method used over two hundred years ago when this dial when first created in the 1790's when an '8' was substituted for the inked in '7' to indicate the change in the century.

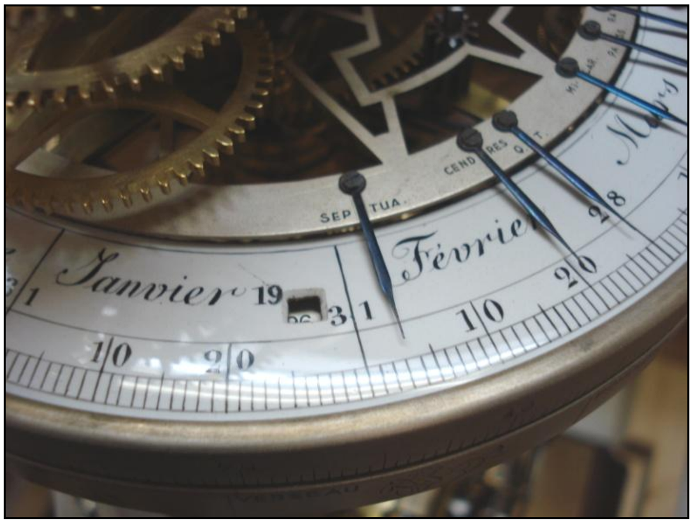


Figure 86. Restored year function showing through aperture

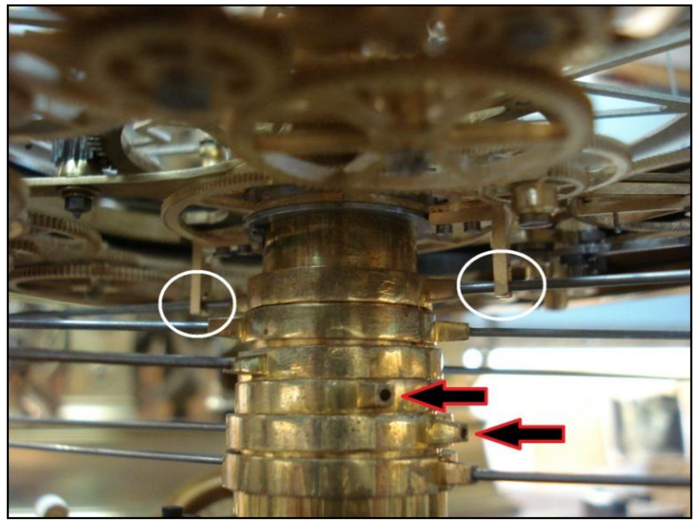


Figure 87. Empty mounting holes on orrery collets, arrows

13. Create planetary signs to fill unused orrery collet mounts. There is a set of six circular collets that are nested below the lower superstructure of the tellurian, see arrows figure 87. There are open holes on each collet which are opposite those used to mount the planets for the orrery. These are the output of the orrery and each rotates according to the six planets outside the orbit of Earth, those are Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. Similar pairs are also used for the inner planets of Mercury and Venus within the tellurian. All of the planets and their connecting wires were missing at the time we received the clock. From a photo taken of Pouvillon next to his clock for a newspaper article in 1953 we can clearly see these collets, (Figure 7a, page 6). On one side of each collet is the attachment point for a planet and on the other it is empty. Another, undated photo, featured in Miclet's article of 1985 also shows his clock with the opposite collet holes open from those holding a planet. Both photos show Pouvillon at about the same age, with the dated photo placing him at an advancing age of 75.

The obvious idea for Pouvillon having created these empty attachment points that comes to mind is that these held a counterweight for each planet. Perhaps, but the weight of each planet and wire is truly miniscule compared to the robust construction of the collets. It seems unlikely, but it does not preclude the possibility that Pouvillon had thought these to be necessary and later abandoned the idea. However, for Pouvillon not to have removed the additional mounts, which would have been a very simple procedure, seems odd. The empty mounting points really do stick out begging the question of what belongs there. It would have been a distraction from Pouvillon's presentation. Further arguing this are the collets for the inner two planets. These planets truly weigh in at under few grams with very short wires to hold the planets therefore generating negligible downward forces; a counterweight would never have been realistically contemplated. But here we

may have a clue. There is a small ring graduated into 360^0 that is positioned beneath the two inner planets, (Figure 88). And the fixed silver upper band surrounding the tellurian and positioned above the zodiac ring is also demarked in the same way, (Figure 91, page 49). Could we somehow use the empty attachment points along with these similarly graduated indicators?

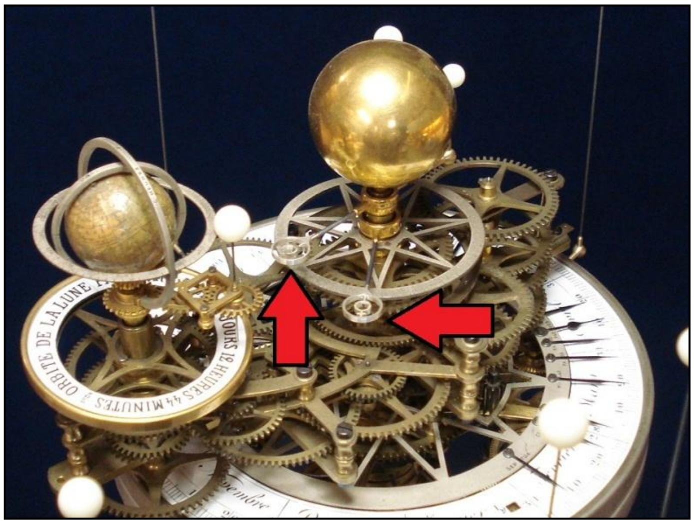


Figure 88. Graduated ring with inner planet zodiac signs

Figure 89. Planet zodiac signs opposite the planets

Here is where we cross the line of restoration completely. Clearly Pouvillon had decided not to remove what seem to be superfluous mounting points by the age of 75. Although he was still tinkering with the clock at this time and did live to 91, it would seem that if he had plans for these redundant mounting points he would have executed them by this time. I found these prominent, empty mounting points a real distraction as did prior owners. As mentioned before there was an advertisement from 1983, in the Antiquarian Horology, by the Paris clock dealer Pierre-Rochefort that shows someone's solution to this problem, (Figure 6a, page 5). The planets were simply mirrored, or doubled so instead of six outer planets we now have twelve, same with the two inner planets doubled to four. Of course Earth is separate and not a part of this. It leads to a somewhat interesting jungle of complication with eight additional planets! All of the planets had disappeared by the time the clock next surfaces at the Antiquorum Auction house in 1995 and remained so until my acquisition, (Figures 6b, 6c, page 5).

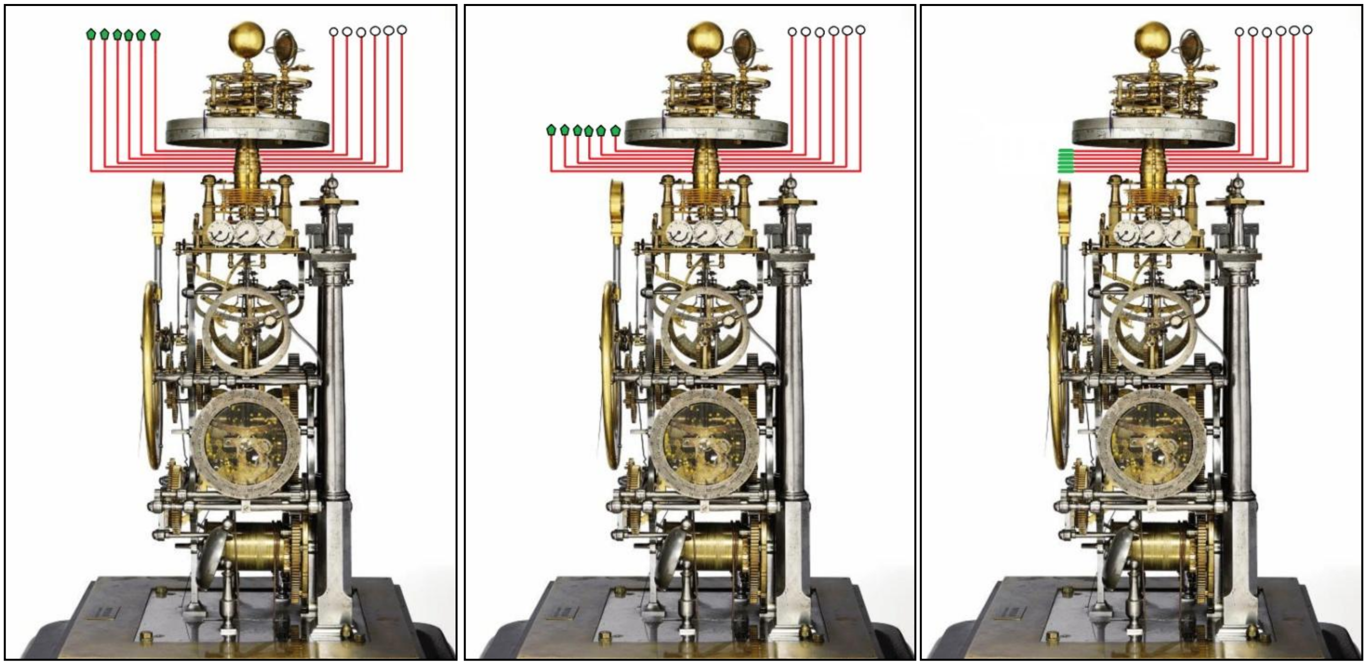


Figure 90 a, b, c

In my opinion doubling the planets made no sense. It completely confuses the picture of where each planet is supposed to be in relationship to its neighbor; obviating a meaningful display of the solar system. So how do we use these empty mounting points? Figures 90a through c give three options. The white circles represent the planets and the green symbols representing each planet's zodiacal sign. Figure a, practically duplicates the configuration of doubling the planets. Figure b, aligns the zodiac symbols to the upper graduated ring, but other than the first symbol, all lay quite far from the scale. Figure c, does not align the symbols to the ring, but does allow all to be closely placed to the ring for ease of reading of the degrees off the graduated ring and more closely resembles how a set of counterweights might have been configured.

Our solution came in the form of the hybrid between a counter-weight and using both the small graduated ring for the inner planets and the upper graduated band surrounding the tellurian for the outer planets. We decided on the third option; to have the zodiacal sign of each planet indicated on a straight arm attached to the empty mounting point on the opposite side of each corresponding planet, (Figure 90c). These indicators, made of silver, have an inward facing teardrop shape and the points are positioned so as to be close to the two graduated rings. In this way one can read, in degrees the position of the planets, albeit 180^0 opposite to the actual planet, (Figure 89). They too can act as counterweights if one wants to do look at it this way. Not a perfect solution, but, in my opinion, better, than doubling the planets or leaving the collet holes empty. And of course this is easily altered by changing the shape of the wire holding the symbols or removed entirely if someone wishes to do so in the future. Figure 91shows an array of the planet zodiacal symbols.
Much of the mechanism was designed by Pouvillon to be a religious calculator, hence the Easter calculator, the Paschal moon dial and the twelve steel dial pointers over the enamel date ring of the tellurian indicating the movable feasts in connection with Easter. Assuming Pouvillon to be a religious man, it's probably unlikely that he intended the clock to be used for astrological purposes. But the fact that one can see the sun and planets as they move through the zodiac and be able to measure their positions to within a close degree of accuracy has many applications in the field of astrology.

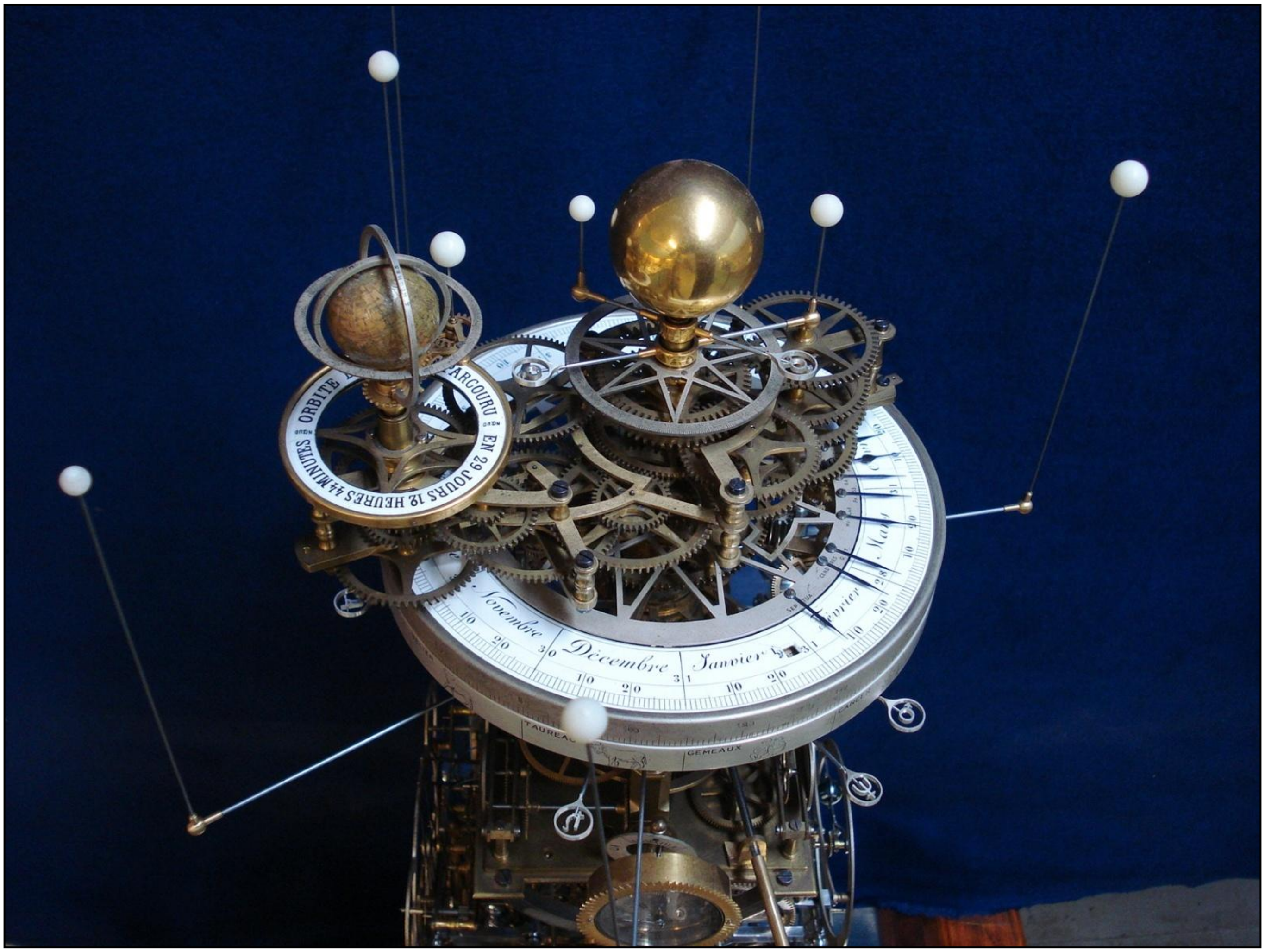


Figure 91. The planet zodiac signs are visible above the small center ring, inner planets and below the outer zodiac band

After the restoration was completed the clock was rated for several months and it came in at a very respectable error rate of 5 seconds per week. This is remarkable for a clock of such complexity. It can be attributed to the fact that Pouvillon used a very heavy pendulum assembly with a good dead beat escapement. He also used the time train to only power the earth, moon system in the tellurian. The rest of the celestial functions in the clock are driven by the strike train. This is a common feature in French clocks that contain complications. It separates the job of driving the complications from the time train and thus insulates that mechanism from the errors that would be introduced from having those features powered by that train. The celestial indicators move very slowly compared to the strike train. Over any twelve hour period, the cumulative output of the strike train is consistent so it goes unnoticed that this method is used. It is an economical way of avoiding the use of a remontoire in the time train to do the same thing. Total parts count for the clock came to over 1500.

Chapter 4. The Restoration of the Wood Pedestal Base for the Pouvillon Clock

The restoration of the wood pedestal was done by an outside firm, and so there are only a few photos of the base as received and then some 'in progress' photos from the cabinet restorer. The restoration work was begun in November of 2011 and completed January of 2012. [15]

Figure 1. Base held for quarantine by Australian Customs

Figure. 2. Close up of damages caused by fumigators

When the wood base was examined by Australian Customs it was found to have had an old infestation of wood worms. Even so, the Customs officials insisted that the base go through quarantine and be fumigated to eliminate any danger of infestation. The clock and base had been well packed in England and had made the journey to Australia without incident. However, the fumigators had damaged the base. It looks like something had either backed into it or ran across it, (Figures 1, 2). This is the nightmare of anyone who ships valuable clocks – damage in transport. Thankfully the clock was not attached to the base at the time and made it through intact. In addition to the scarring along the upper edge, the base was slightly smashed, probably from impact with a forklift truck. Here we have a close up of the lower section damages, Figures 3, 4)

Figure 3. Further damage to the lower edge of the base

Figure 4. Close up of impact damage to lower edge.

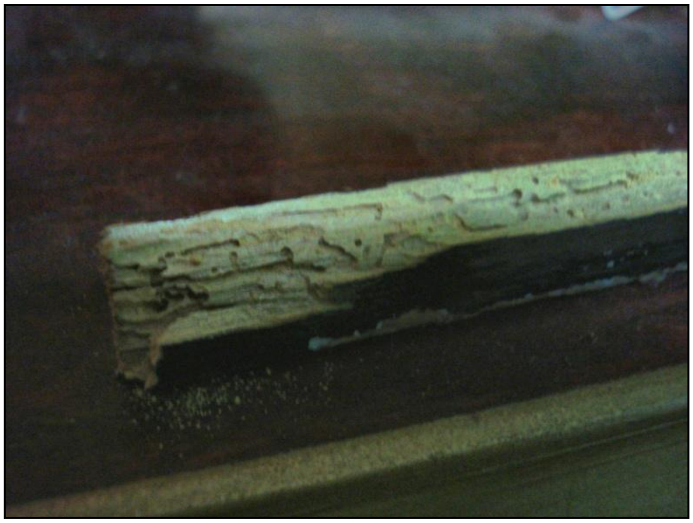


Figure 5. Extensive wood worm damage, starting to crumble **Figure 6. Further damaged areas**

Figure 5 shows a section of wood that had come away with extensive wood worm damage. Notice the wood powdering near the lower end; the structure is beginning to crumble. Figure 6 shows another section with similar damage. At this point we were unsure if the case had retained enough structural integrity to support the heavy weights that powered the clock.

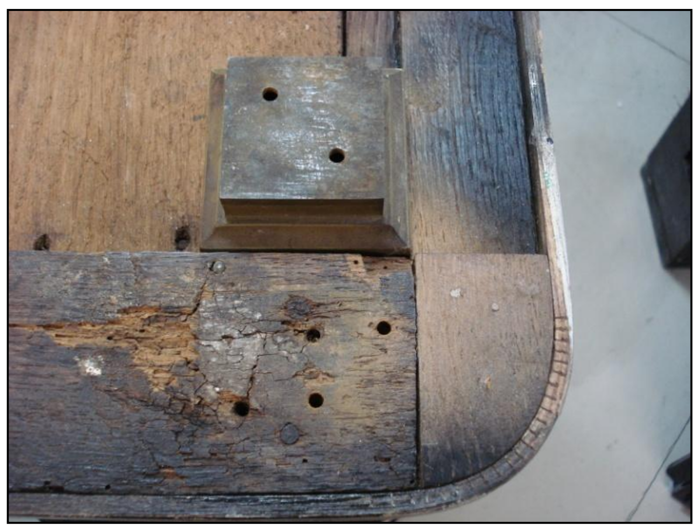


Figure 7. Wood insert below where brass foot is attached **Figure 8. Evidence of foot repositioned or replaced**

Figures 7 and 8 show two areas of the underside where the brass feet are secured. In the first photo one can see the area adjacent to the removed brass foot that has been filled in with a later wood section. Most likely the wood insert was necessary after that area had suffered numerous changes resulting in too many holes, weakening that area. The next photo depicts another mounting point with evidence that the foot has been moved at least once or that an alternative foot with another set of holes was used before the current version.

In figure 9 we show the lower seat board for the clock. One can see the numerous holes indicating the various changes in either position or hardware that was attached to this piece. This lower seat board has the upper weight pulley set attached. There are two seat boards, sandwiched one upon the other. The upper board is

attached to the clock and the decorative wood trim surround. It lifts off the base with the clock attached; allowing for easy transport and presentation of the clock without the base.

Figure 9. Lower seat board

Figure. 10. Lower seat board with pulley sets attached

Figure 11. View of pedestal floor

Figure 12. Initial structural integrity test, rigging up weights

The weights are triple compounded and so are quite heavy requiring the case to have a good structural integrity. The rigging from above is shown, (Figure 10) as well as one of the weights from below, (Figure 11). After an initial trial it appears that the seat board is sufficiently strong to take the weights

Buchanan decided to gingerly rig up the weights and after the broken pendulum rod was repaired, we initiated the pendulum. Needless to say the clock would only tick for a brief period of time before stopping. The movement has been in disrepair for at least the past 28 years as we know from photographic evidence as far back as 1983 that the clock has been unchanged from that time though the present. The base appears at this point to have enough integrity to support the weights and clock

Figure 13. Base access door showing sever warping

Figure 14. This is as far as the door can close

Next we evaluated the base access door. It was severely warped and there was no prospect of it ever closing properly in its current state, (Figures 13, 14).

Figure 15. An indication of the original finish on inside

Figure 16. Initial removal of black spray paint overlay

Figure 15 shows evidence that the wood base did not originally have a black, painted finish. In fact, upon close inspection the black finish was a spray painted coating on the underlying wood finish. The spray painted finish seemed to be fairly easy to scrape off without causing too much damage to the underlying surface, (Figure 16).

Figure 17. Wood filler hiding damages to the access door

Figure 18. Deep gouges revealed after wood filler is removed

This section of paneling appeared to be in fair condition and so hopes were raised that the rest of the cabinet would yield the same results. We were cautiously optimistic at what appeared to be our good fortune. This was to be short-lived. Of course why would anyone spray paint a perfectly good wood grained cabinet? Well we were about to find out.

The first evidence of damage, one of many areas which ultimately lead to the cabinet being painted, was located in the base access door. After the paint was removed we found several very deep gouges were hidden by filler before being painted, (Figures 17, 18).


Figure 19. Example of damage to base of pedestal


Figure 20. Replaced wood to surround of upper seat board

Figure 19 shows another gouged out area near the base. Figure 20 depicts an area where wood was extensively replaced with later joined wood on an area of the upper decorative surround molding to the base of the upper seat board.


Figure 21. Wood filler hiding defective areas prior to paint


Figure 22. Wood filler hiding defective areas prior to paint

Figures 21 and 22, further illustrate areas with wood filler. These were put in prior to the black paint finish.

Figure 23. Curiously repaired area using dowel and blocks

Figure 24. Additional wood filler area.

Figure 23 shows a curiously repaired area where apparently wood doweling as well as a wood block was used to repair a broken section. In the next photo we see another wood filler area.

Figure 25. More evidence of gouging and scratching

Figure 26. Different shading between wood sections

Figure 25 has more filled cracks and in figure 26 more damage to the left edge of the front, center panel. There were countless areas of scratches gouges and other signs of abuse and neglect all over the surface of the base. The base is made of oak and was originally stained to a mahogany color finish.

The extensive damages may be explained by a correspondence we have from an elderly resident of Mr. Pouvillon's home town who remembered seeing him and his clock as a young man of 14 or 15 years old in 1938 to 1940.[9] He remembered that the clock suffered a major accident during transportation to an exhibition in the early 1950's. We see no evidence of the clock movement itself having suffered any damage. The clock was designed to be easily removable from the base for just this contingency of transport as well as display. So it's likely that the damage he referred to happed to wood base while the clock was removed. This would explain all of the severe gouges and replacement parts. The worm wood damage could well have occurred

without the knowledge of Mr. Pouvillon until after the accident, and might have contributed to the decision to paint the case, if it had already occurred by then. By this time he was at least 72 to 75 years old. He may have not had the money or inclination to properly repair the case. There is no doubt that the base was originally a wood grained finish.

There were very few areas that could have been salvaged in a presentable fashion by merely scraping off the black spray painted top coat. So we were left with the following options:

A. Forget about the fact that the base originally had a wood grained finish and paint the case back to the way we found it, that is a glossy black finish.

B. Try to refinish the case back to what the original case finish looked like while keeping as much of the original material as possible and accepting the fact that prior repairs and damaged would be visible.

C. Create a new base in the same manner as the original and finish it off in the same manner.

Choosing C would not be in keeping with our restoration goals within the scope of this project and was not even considered, especially since we had determined that even with all of the existing problems the structural integrity of the base had not been compromised. However the choice between A and B was a difficult one as were several of the restoration steps we took with the clock movement itself. The strict conservator faction would say we should have never have touched the black finish in the first place and given that we did should simply repaint the areas where we removed the paint back to a finish as close to the rest of the black finish still in place.

Again a judgment call was needed. The base, as designed by Pouvillon had a wood grained finish. From what was exposed, I could see that if it could be brought back to that state, even with the flaws, that it would be far more attractive than the later black finish. So in summary B was chosen. Following are photos of the restored base.

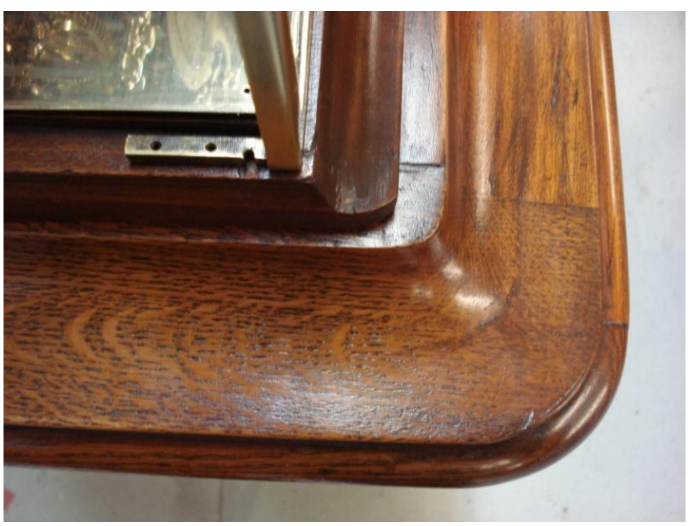


Figure 27. Restored finish

Figure 28. Restored finish

Figure 29. An overview of the refinished base

Figure. 30. An overview of the refinished base.

The seat board one sees on the top is the upper seat board upon which the clock is attached, (Figure 29, 30). Figures 31, 32, display the skill of the cabinet maker to hide the flaws inherent in the original repaired case. The access door rails were carefully stretched back to conform back to a flat profile, (Figure 33). Compare this to the way the door was originally warped, (Figure 13, page 53).The center panel had suffered too much damage to be salvageable and a new carcass of plywood was used to prevent any future warping and to this plywood was then applied an oak veneer with a matching grain on both sides. This is how one gets a mirrored graining on both sides of the door to give it the look of a panel made from a single, solid material, (Figure 30, 34). The interior of the case was left untouched aside from a cleaning.

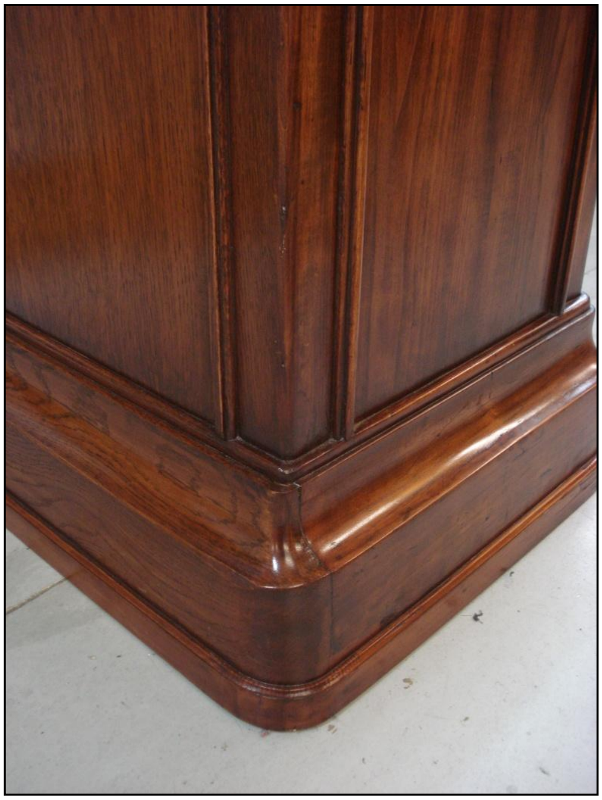


Figure 31. Detail of lower right corner

Figure 32. Same view as in figure 31

Figure 33. Warped door now straightened

Figure 34. Veneered inside center panel of door

Chapter 5. Discussion of Restoration Philosophy and Conclusion

Figure 1. Front elevation

Figure 2. Three quarter view

Figure 3. Left elevation

Figure 4. Right elevation.

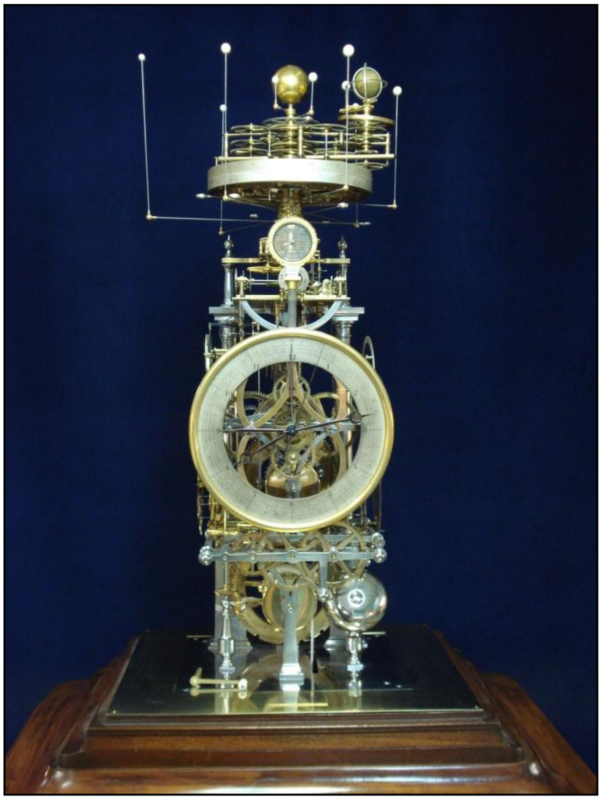


Figure 5. Front elevation

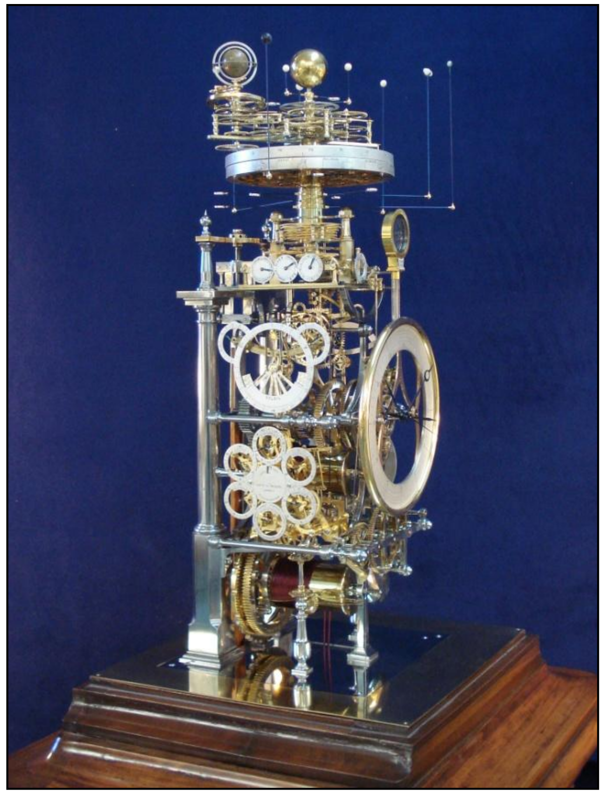


Figure 6. Left elevation

Figure 7. Right elevation

Figure 8. Rear elevation

Figure 9. Right, below the tellurian structure

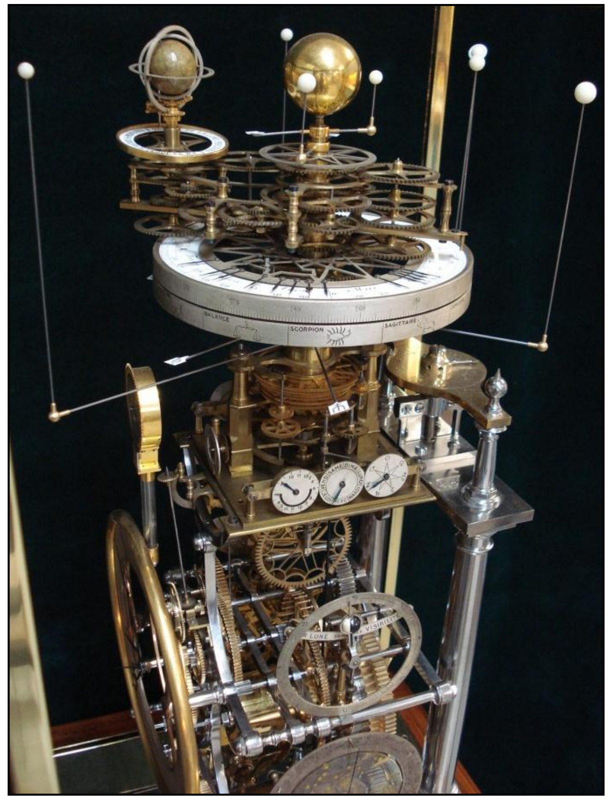


Figure 10. Right, above the tellurian structure

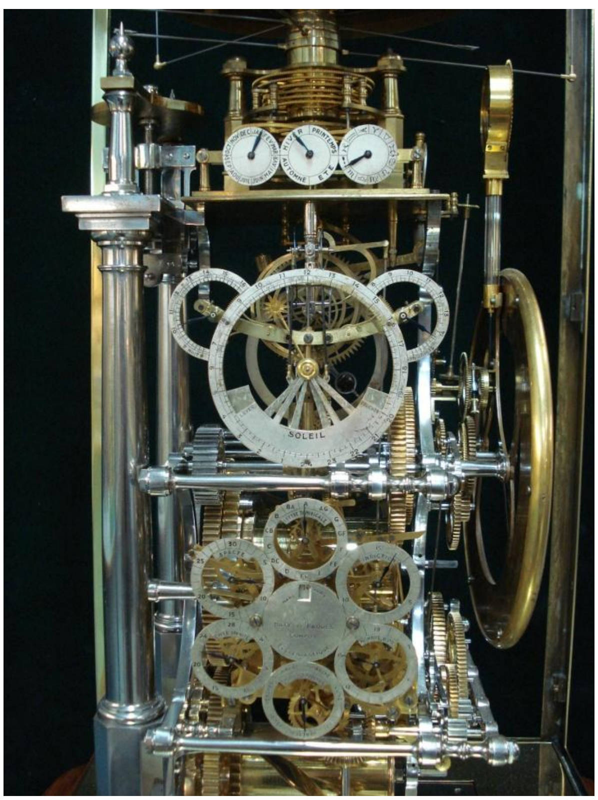


Figure 11. Left, sunrise/set, Easter calculator

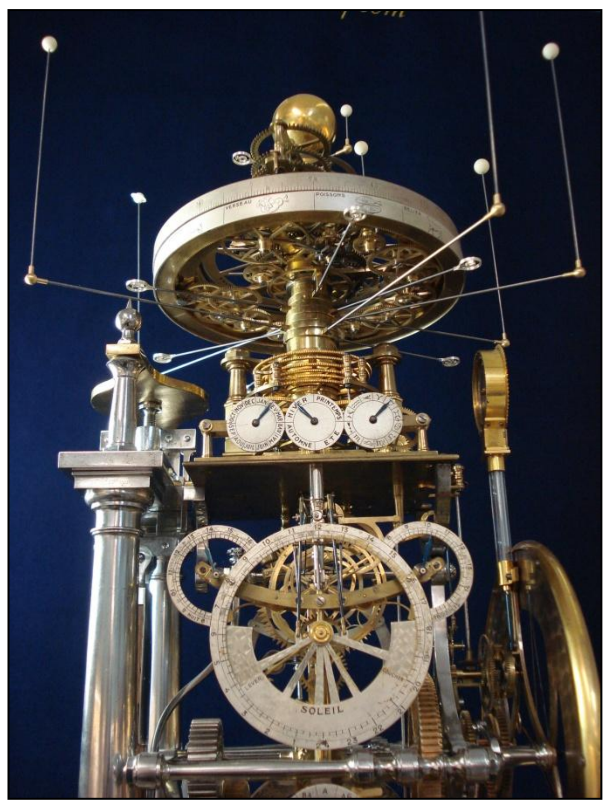
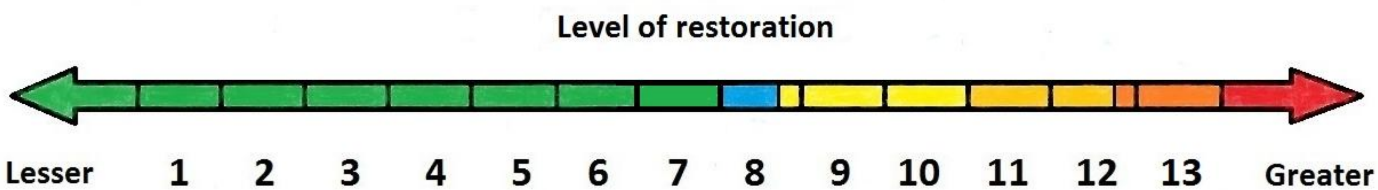


Figure 12. Left, below tellurian structure

Illustrated below are the thirteen sections we described within this article outlining our restorations with regards to the various mechanical areas of the Pouvillon astronomical clock. The low end, 1-7 and in green, shows those restorations where we have solid historical written or photographic evidence for our restored components. Next up the line, 8 and in blue, would be areas where we have ample circumstantial evidence from the artifact itself to give us a very good idea of not only the functionality of the part, but how it should look. Next we use the same circumstantial evidence with confidence for the functionality of the part but with less certainty as to exactly how the part might have looked 9 and 10 yellow area. Next we use inference and circumstantial evidence, from the artifact coupled with articles and interviews by second parties with and about Pouvillon to recreate a major complication that probably once existed. A second complication is recreated because the first made it easy to do so and we believe Pouvillon would have done this, even though we have no proof if Pouvillon had ever done this or not, 11 and 12 dark yellow area. Finally we add something that was probably never done in the exact way we attempted it in an effort to use locations left vacant by Pouvillon, reflecting something that was also done thirty years ago by a second party, 13 orange areas.



1. Repair broken pendulum rod
2. Repair weight pulley system
3. Secure time train click spring
4. Replace broken glass drive tube and retouch numerals on ‘mystery dial’
5. Restore annular cam pack
6. Restore missing tellurian and orrery planets and attachment wires
7. Restore sunrise/sunset dial spiral bias springs, replace missing hand
8. Restore sunrise/sunset shutter bias springs
9. Repairs to the Easter calculator
   a. Restore automatic annual trip linkage, calculator to cam pack
   b. Restore warning and trip mechanism in calculator
   c. Restore calculator’s perpetual Epact function
   d. Replace missing calculator drive chain
10. Restore orrery demonstration crank
11. Restore zodiac precession complication
12. Restore annual year indication
13. Create planetary signs to fill unused orrery collet mounts

The thirteen categories discussed in this article represent the entire range of the mechanical restorations, repairs, replacements and in the last instance, simply an addition to this clock. They fall into the spectrum from conservative restoration and repair to what some would say is out of bounds. Little detailed here would make the preservationist camp happy.

In our defense the first and foremost thing to remember is that ***everything*** we have done is ***fully reversible*** and that ***no alterations*** were made to the original artifact. No holes, no cuts no alterations in the profiles of

any piece of the clock. The exceptions as outlined in the restoration of the Easter calculator are the removal of two parts that were clearly later additions and could not function as intended, as well as the weight pulley bearings and replacement of the center panel of the base access door.

We have also fully documented through this writing and on my website exactly what was done and so we hide nothing. As a backstop to those who might claim that our online and written restorations could be lost I have included a full written description of what we have restored and the date attached to the interior of the clock base. It is true that we did try to make the restored components look as much as we knew how to appear as if they were original to the clock. In some circles it is demanded that any restored parts be purposefully made to stand out visually so as to be readily identified as later replacements. In this way one avoids any misunderstandings in the future should the written record be lost. This may be appropriate for a movement that is contained within a conventionally cased clock, where such parts are fully functional, but not readily visible. But here, all parts are visible and aesthetically integrated. It would be, in my opinion, as nearly tragic to have these components damaging what otherwise is a visual masterpiece in horology as it would be to have left it as found – a broken, forlorn piece of mechanical art and one that is begging to be made whole again. There is a long, sad history of complex horological master works that once having fallen into disrepair became victims of indifference or neglect and thus were ultimately lost or destroyed.

So did we go too far? This can be argued by the restoration verses preservation camps. I can only say, that should a future owner decide that I was wrong, he can always revert the clock back just a few or as many steps as he pleases, even to the original state of the many missing components and the clock being a static device. I have not stood irreparably in the way of the preservationist camp.

I do think Pouvillon would be pleased that his work is now fully functional and its base brought back to the original, beautiful wood finish. I know I am. Please feel free to contact me with any questions or comments through my website email.[16]

Footnotes:

[1] Bernard Miclet, 'Paul Pouvillon M.O.F. et son Horloge à Planetaire', *Bulletin of A.N.C.A.H.A.*, No.43, summer 1985, 23-28

[2] Figures 2-5 and associated information courtesy of Alain BINET, a local genealogist of Nogent-sur-Oise, email of 12/11/11, 12/13/11

[3] Courtesy of Jean-Pierre Rochefort, email of 12/10/12

[4] The Clockmaker Rasmus Sornes, Tor Sornes: 135-136

[5] Advertisement by Jean-Pierre Rochefort, *Antiquarian Horology*, Vol.14, No.3, September. 1983: 325

[6] *Antoquorum* auction catalog, Geneva, Switzerland, April 23, 1995, Lot #162

[7] *Christie's* auction catalog, London, England, December 9, 2009, auction #7822, lot #344

[8] Author unknown, newspaper clipping written in France, presumably Paris or Nogent-sur-Oise, hand dated 1953.

[9] Courtesy of Jacques Armspach, a local resident of Nogent-sur-Oise, email of 02/24/12

[10] *Christies* auction catalog, London, England, June 12, 1996, auction #5650, lot #269
The same item also appears in Michel Hayard, *Antide Janvier* (Paris, Lelivredart, 2011): 291.
An identical tellurian dial but made with a metal instead of enamel dial
Sotheby's auction catalog, Amsterdam, Netherlands, June 7, 2005 auction #AM0964, lot #177

[11] http://www.my-time-machines.net/pouvillon_restoration8.htm

[12] Jacques Modane, Paul Pouvillon, Horloger á Nogent-sur-Oise, *Le Parisien*, February 20, 1955

[13] Buchanan of Chelmsford, P.O. Box 1059, Moss Vale, NSW, Australia 2577, clocks@buchananesq.com

[14] Elephant ivory tusks, www.elephantivorytusks.com

[15] The case restoration firm was Ian Ellis Antique Restoration and French Polishing, Wollongong NSW, Australia

[16] mfrank1@rcn.com

Appendix A.

Explanation of the function for the dials located on the Easter Calculator

Dominical letters (Lettre Dominicale) The dominical letter of a year is defined as the letter of the cycle corresponding to the day upon which the first Sunday (and thus every subsequent Sunday) falls and is denoted by the first seven letters of the alphabet, A, B, C, D, E, F, and G with the letter A always set against January 1st as an aid for finding the day of the week of a given calendar date and in calculating Easter. Leap years have two Dominical Letters, the second of which is the letter of the cycle preceding the first; the second letter describes the portion of the year after the leap day. In the Julian calendar, the cycle is 28 years, 7 of which are leap years, and the remaining 21 are common years. Each of the seven Dominical letters is split evenly among the 21 common years, and each of the seven double letters for leap years, BA, CB, DC, ED, FE, GF, and AG, occur once in every 28-year cycle.

Epact (Epacte) (Latin *epactae*, from Greek: *epaktai hèmerai* = added days) was originally defined as the age of the moon in days on January 1, and occurs primarily in connection with tabular methods for determining the date of Easter. It varies (usually by 11 days) from year to year, because of the difference between the solar year of 365 days and the lunar year of 354 days.

Golden Number (Numbre d Or): The number of the year in the lunar cycle is the golden number and was found by Meton, the Athenian who in the year 430 discovered that 19 tropic years coincided very nearly with 235 synodic periods of the moon, in other words the moon is in the same position in the sky with respect to the surrounding stars every 19 years (the Metonic cycle), and the ancient Greeks thought this so extraordinary that they are said to have cut these numbers on buildings and highlighted them in gold.

The lunar cycle is a period of 19 years, after which the phases of the moon again fall on approximately the same dates in the solar year. The number of the year in the period is found by adding 1 to the number of the year and dividing by 19; the remainder is the number of the year. If there is no remainder, the number of the year-or the golden number is 19.

Solar Cycle (Cycle Solaire): The solar cycle is the period of 4 times 7 = 28 years, after which period of days of the week in the Julian calendar again fall on the same dates in the solar year. The number of the year in the period is found by adding 9 to the golden number of the year and dividing by 28; the remainder is then the number of the year. If there is no remainder, the number is 28.

Indiction: The cycle of indiction is a period of 15 years but has no connection with astronomical periods. Nothing is known for certain about its origin, perhaps it was used by the Romans, possibly as an interest or fiscal term, but it is continuous from that time throughout the reckoning. The number of the year in the indiction is found by adding 3 to the number of the year and dividing by 15. The remainder is the number of the year. If there is no remainder, the number of the year is 15. The three cycles, the solar cycle, golden number and indiction together form a period of 28 x 19 x 15 = 7,980 years. This period has often been used in ancient times for the dating of documents; in addition to the rather uncertain date, the number of the year in the three cycles were given. In this way the year can be determined with perfect certainty. If a year is denoted by, say, solar cycle 12, indiction 3 and golden number 9, it will be an easy matter to fix the year at 255 after our reckoning. The three cycle numbers will only fit in for that year or for years 7,980 years before or after it.

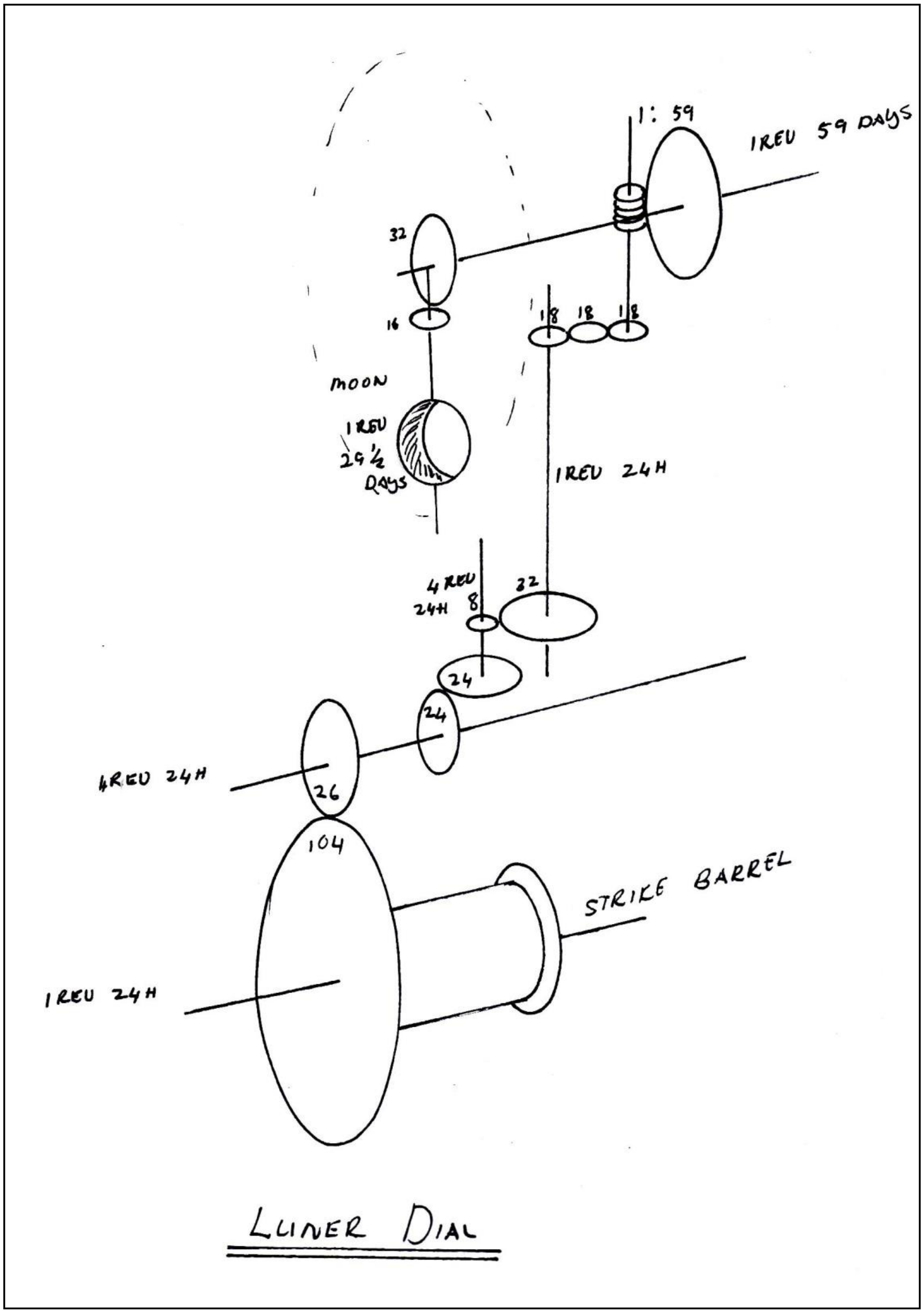
The period 7,980 years is called the Julian period. Year 1933, which has solar cycle 10, indiction 1 and golden number 15, is the 6,645th year in the Julian period. This dial is not needed for the Easter calculation

Day of the week that January 1st falls on (1ca Janvier Prochain): This dial is self explanatory and not used for the Easter calculation

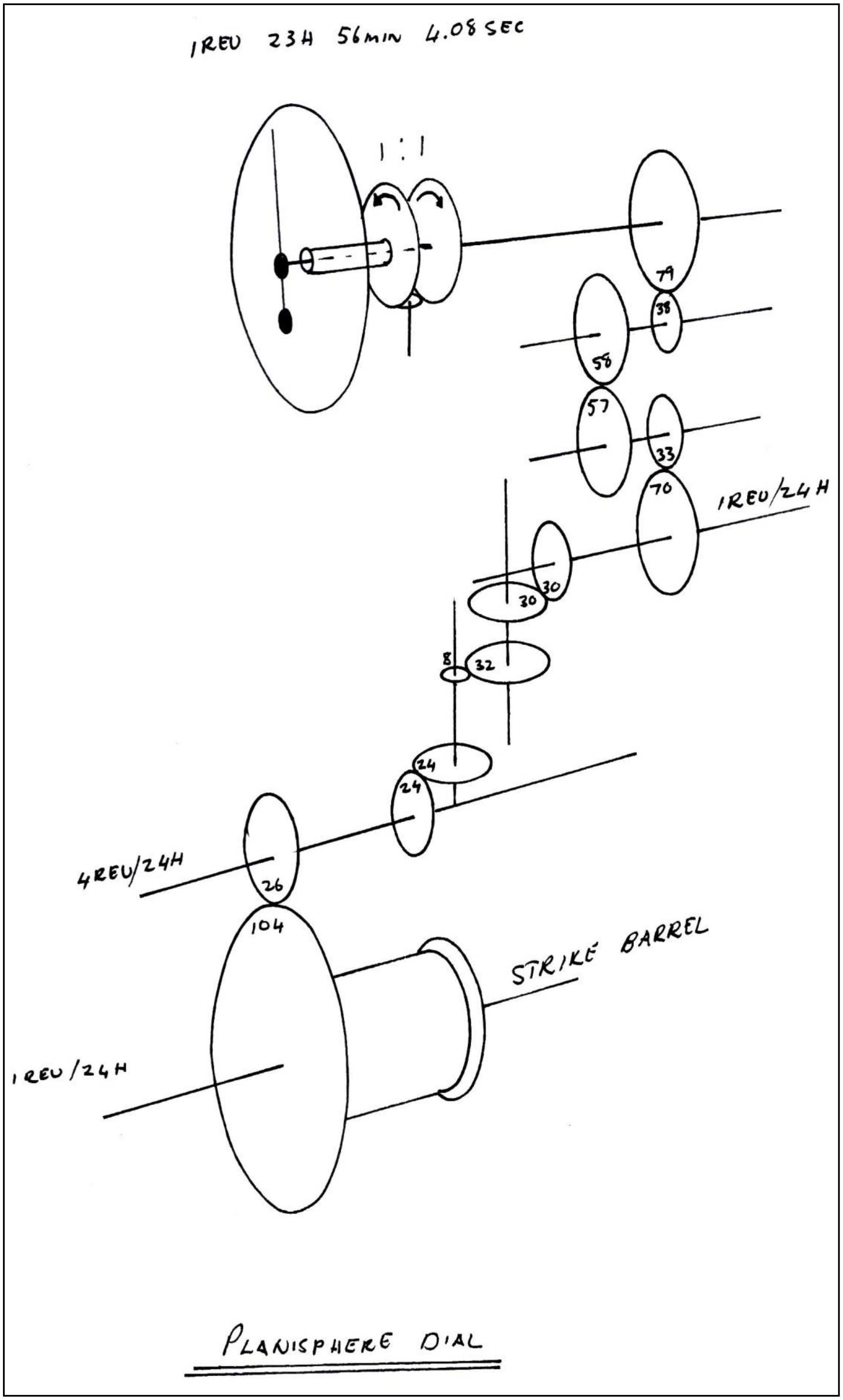
Appendix B.

Schematics for the Pouvillon Clock

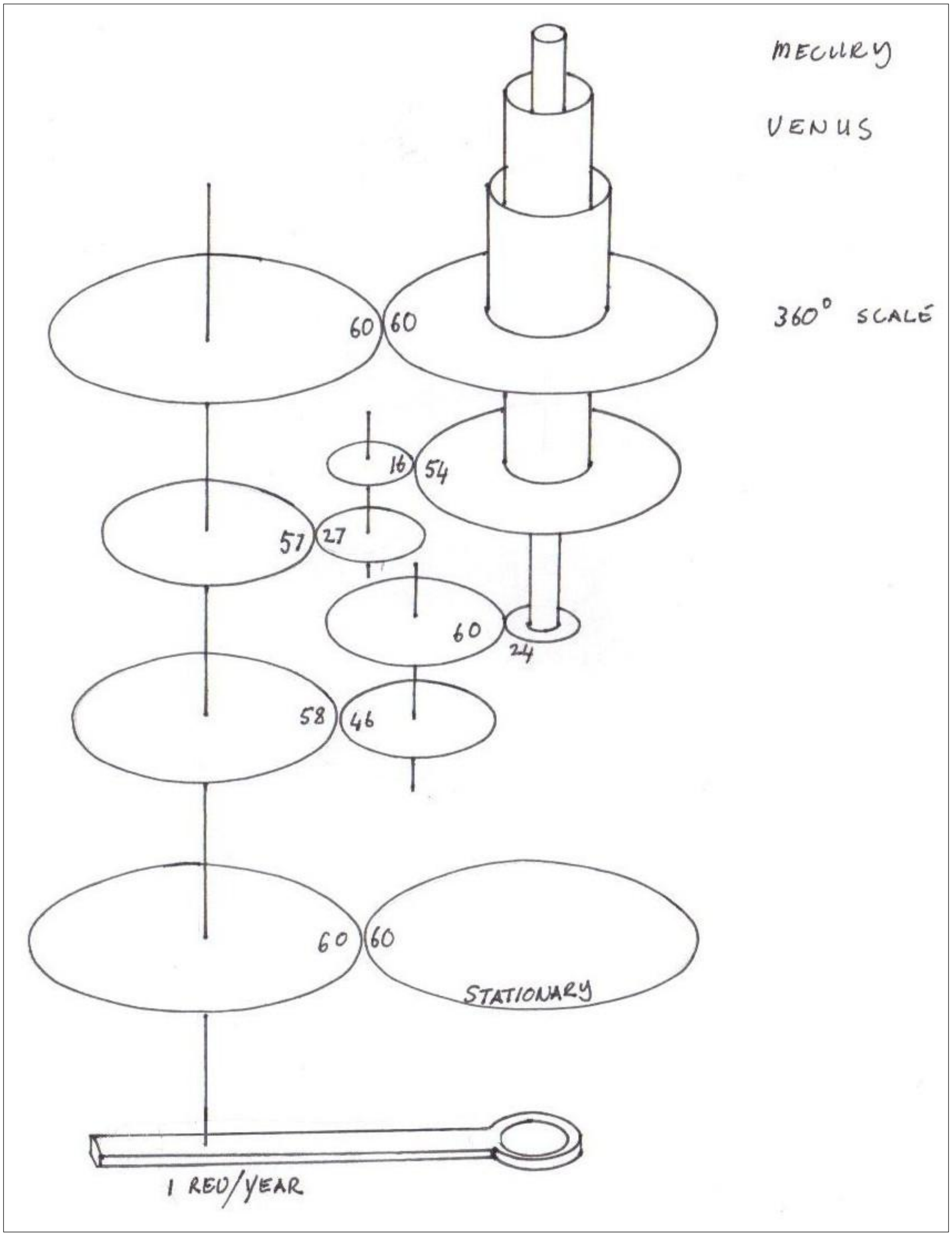
Shown here are the diagrammatical sketches of the **lunar dial** and the **planisphere dial**, next page. These two complications had to be devised at the same time as their feeds are conjoined.



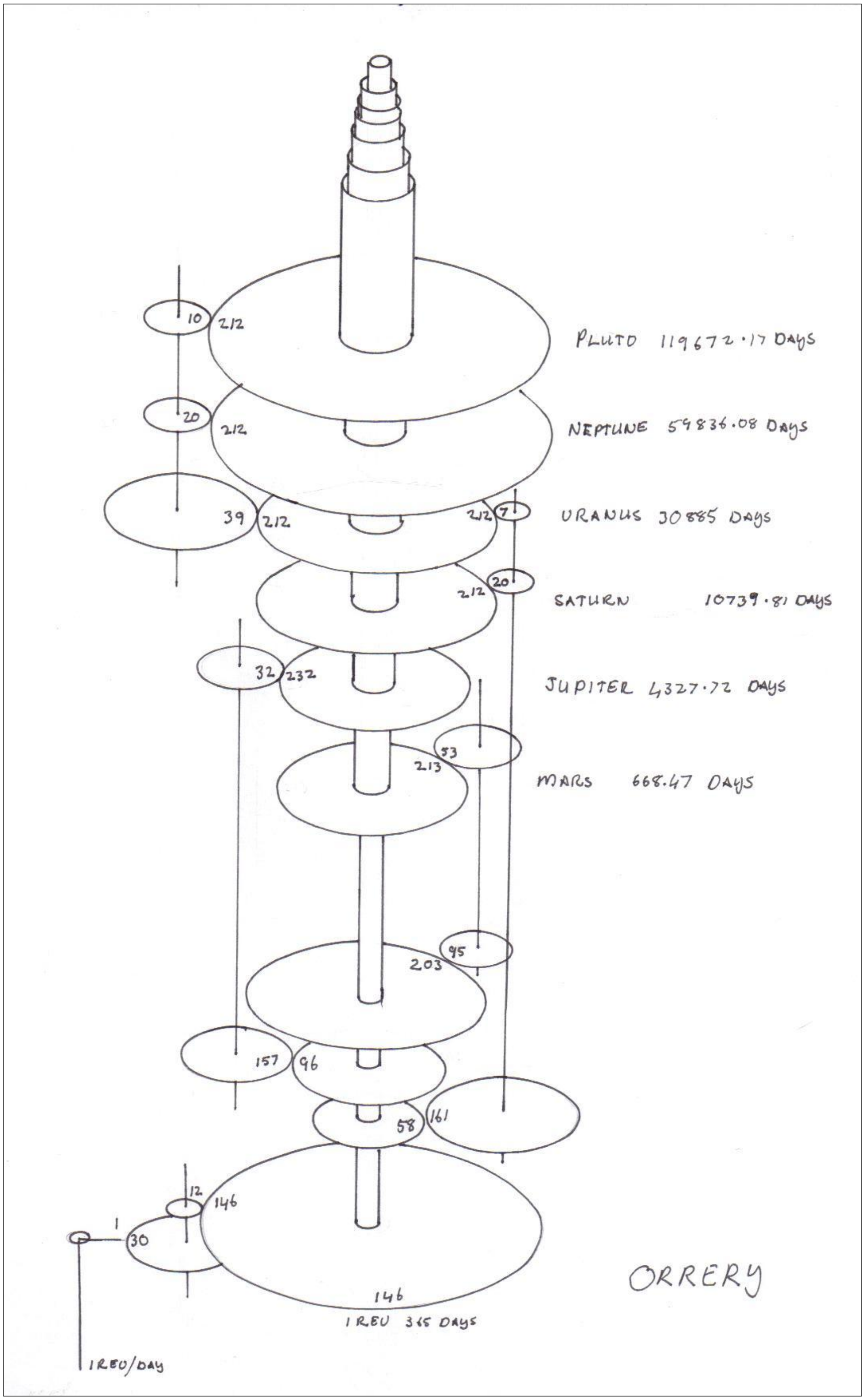
This drawing depicts the planisphere dial



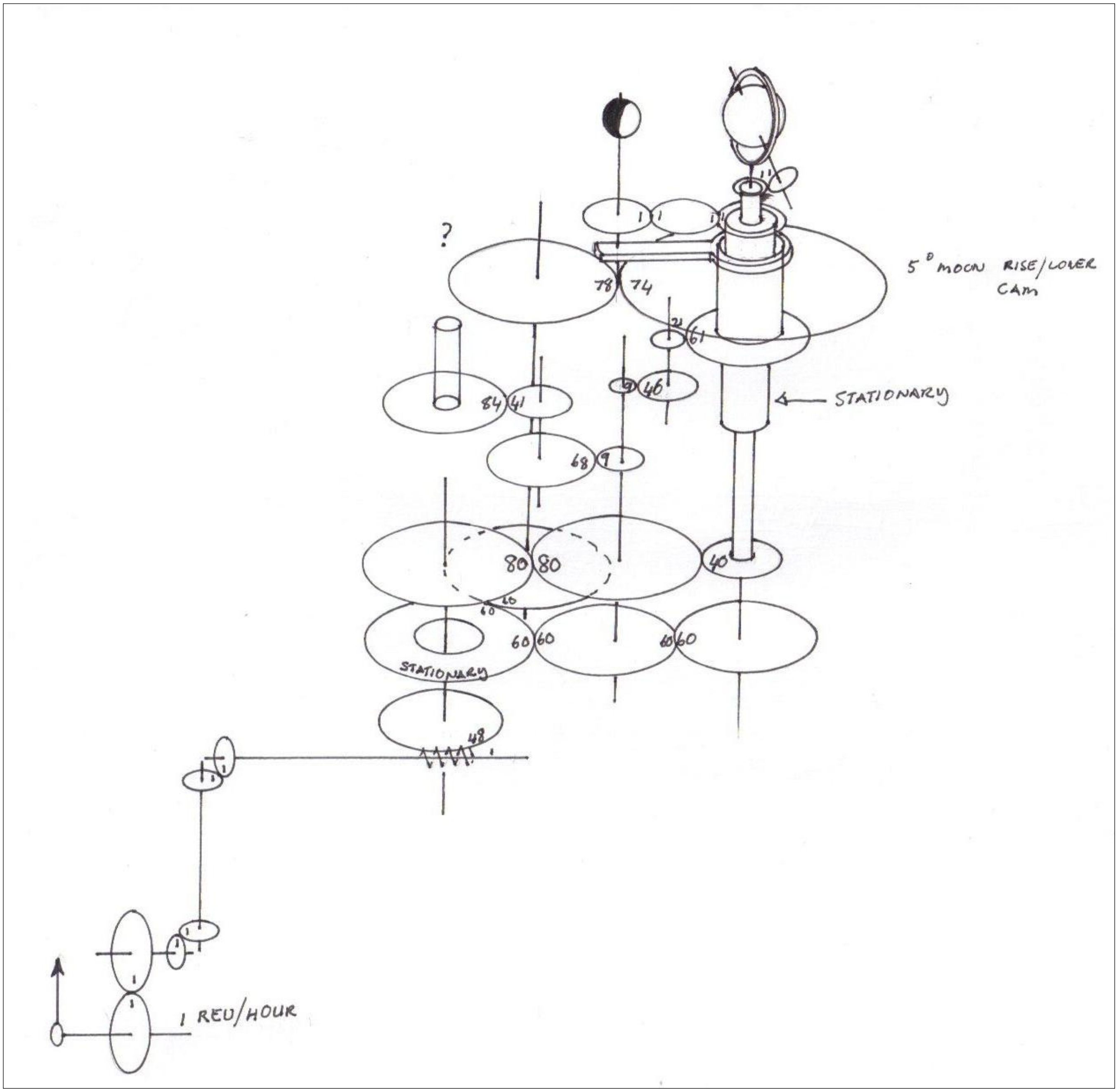
This drawing depicts the orrery details for the inner planets of Mercury and Venus.



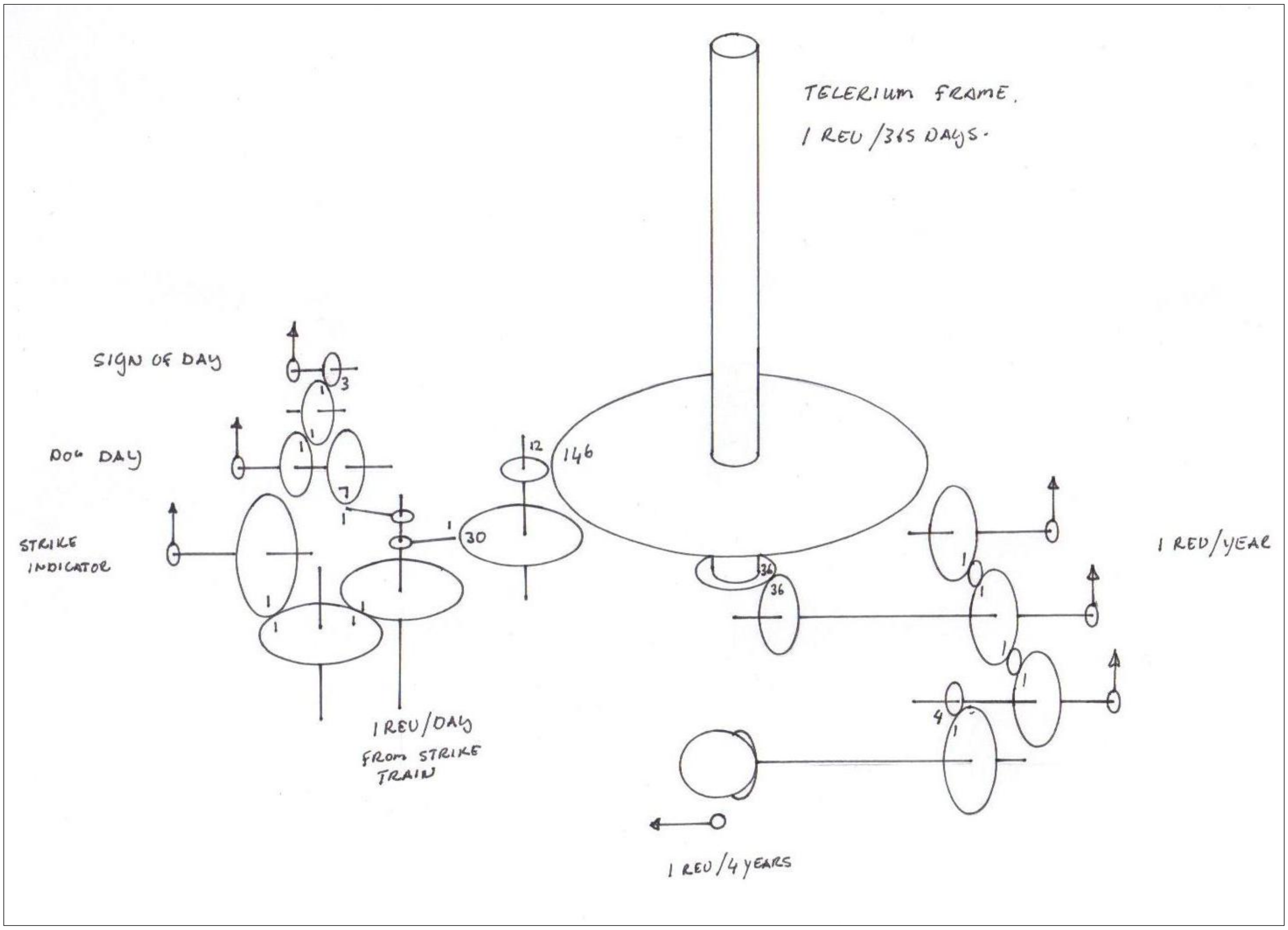
This drawing depicts the orrery for the outer planets of Mars, Jupiter, Saturn, Uranus, Neptune and Pluto.



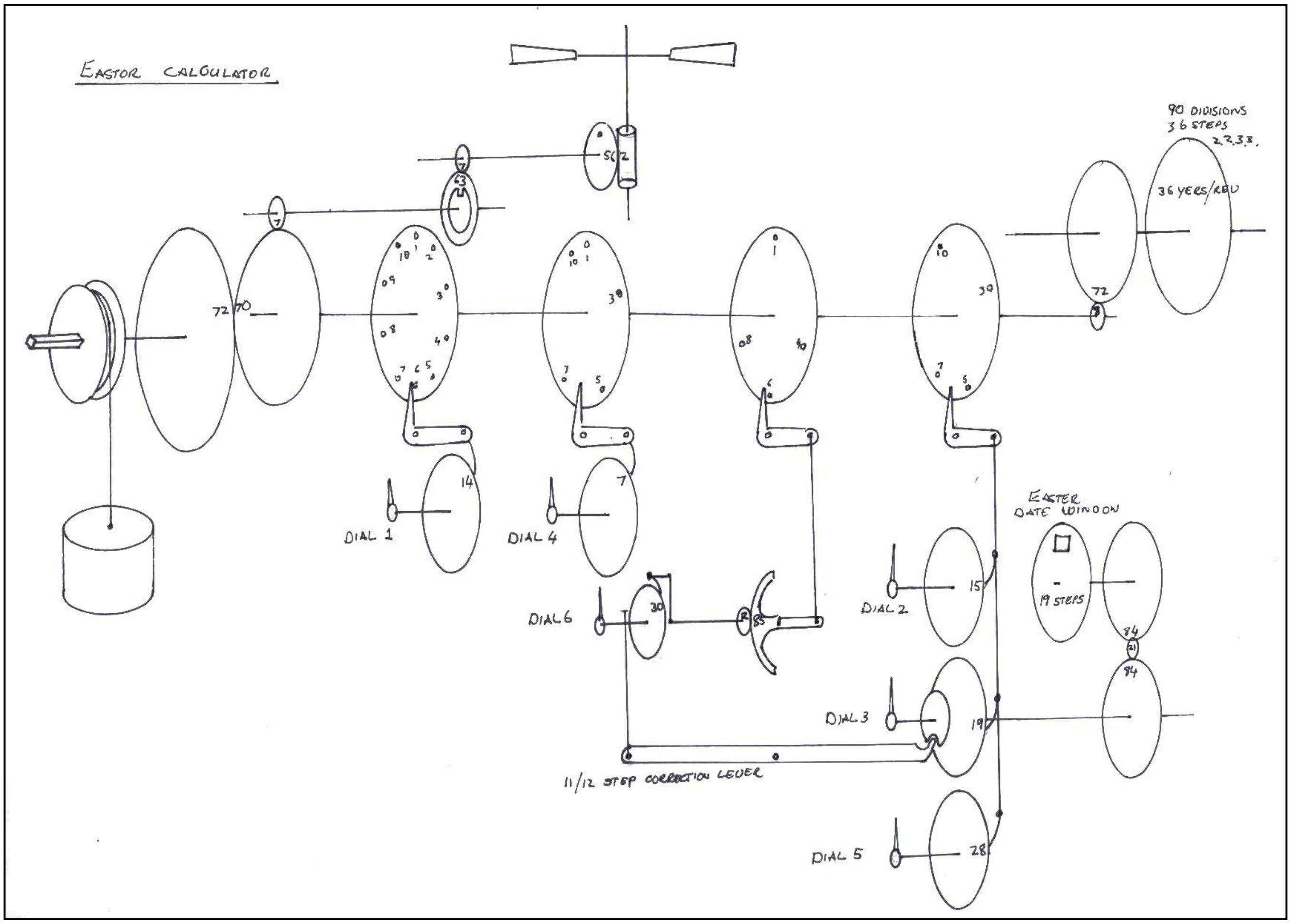
This drawing depicts the tellurian showing the Sun, Earth and moon system.



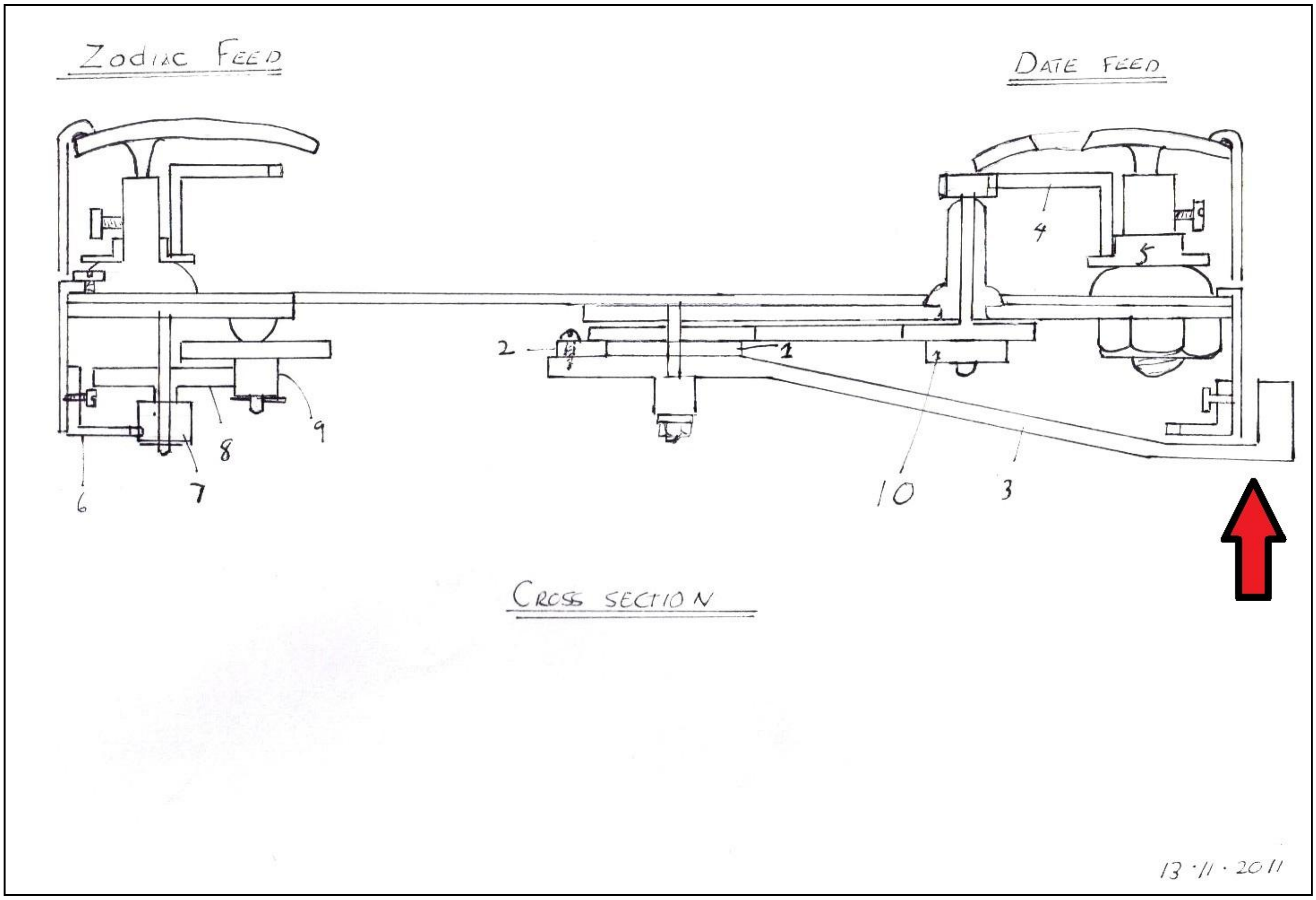
This drawing depicts the seven small dials that surround the tellurian/orrery superstructure's base. The left bank of dials as seen from the front of the mechanism comprise the strike indicator (unequal numbered dial), the zodiac sign for the day, the day's common name. On the right bank are the zodiac sign for the month, the month's common name and the four seasons. The front dial is the leap year indication.



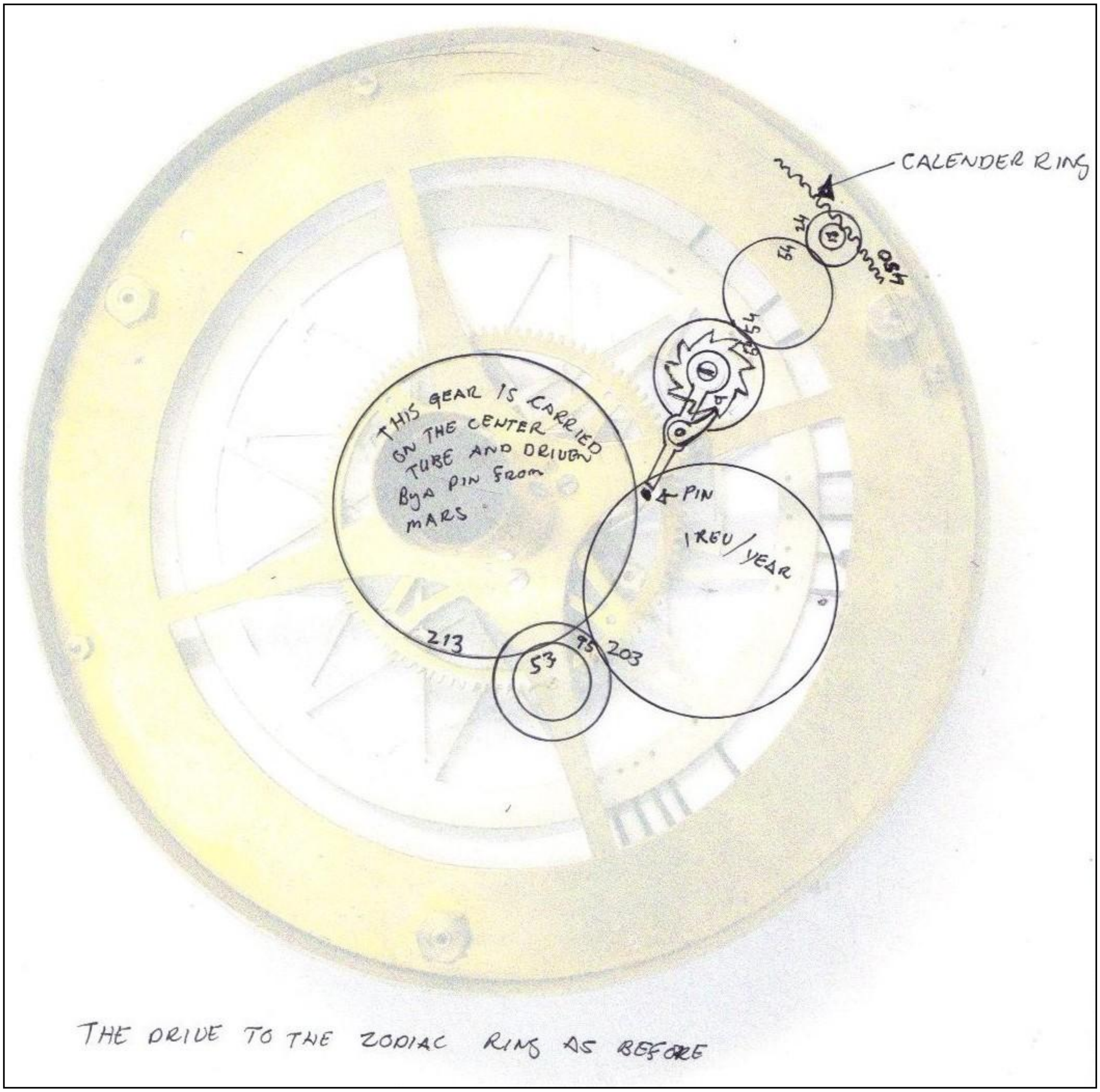
This drawing depicts the workings of the Easter calculator.



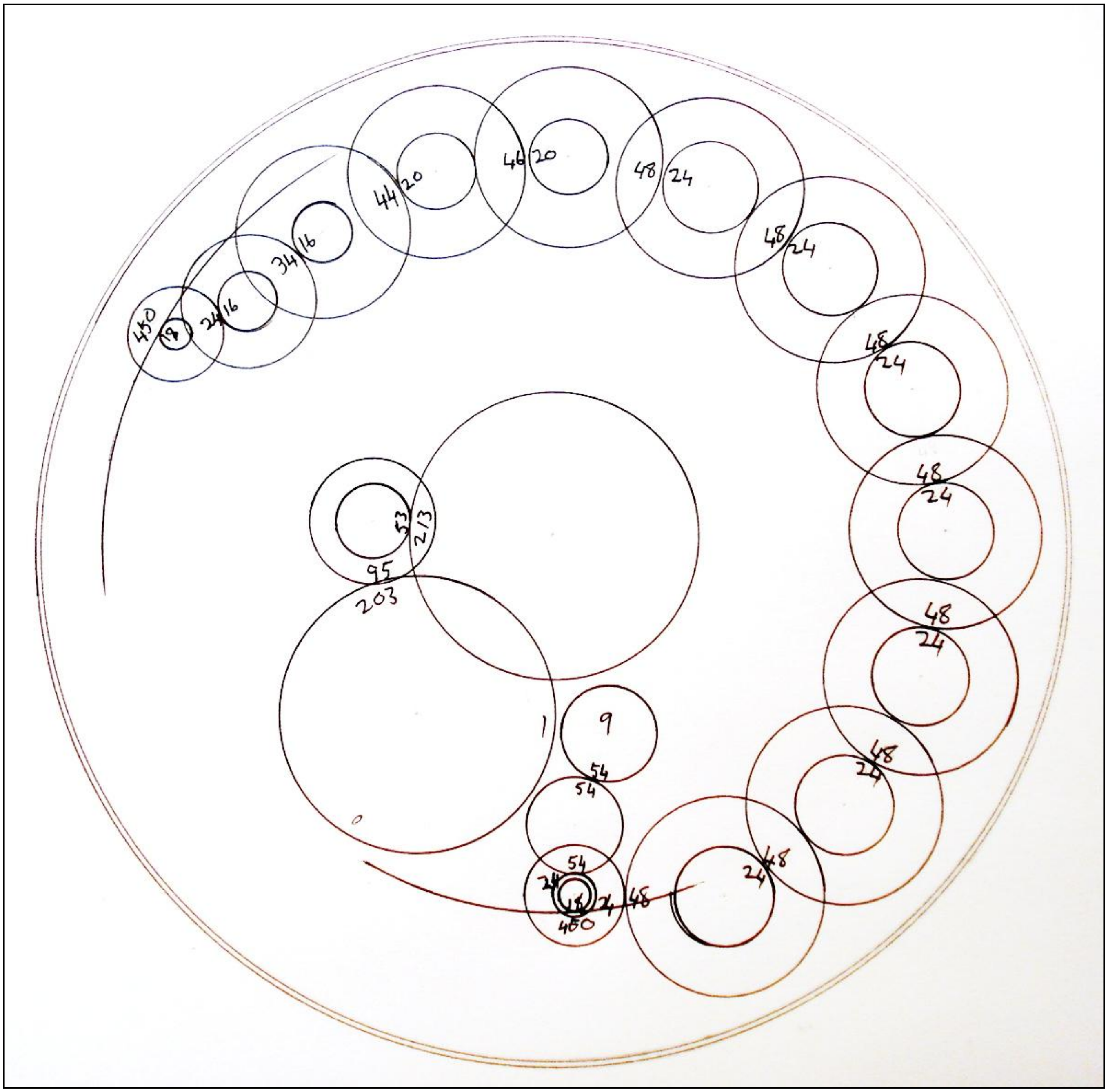
This drawing shows the drive for the zodiac precession. A change was made, see next page, to the actual initiator, from an external flag on the outside of the lower zodiac band, red arrow, to the drive being taken from the arm of the planet Mars, the uppermost planet in the orrery nest directly below.



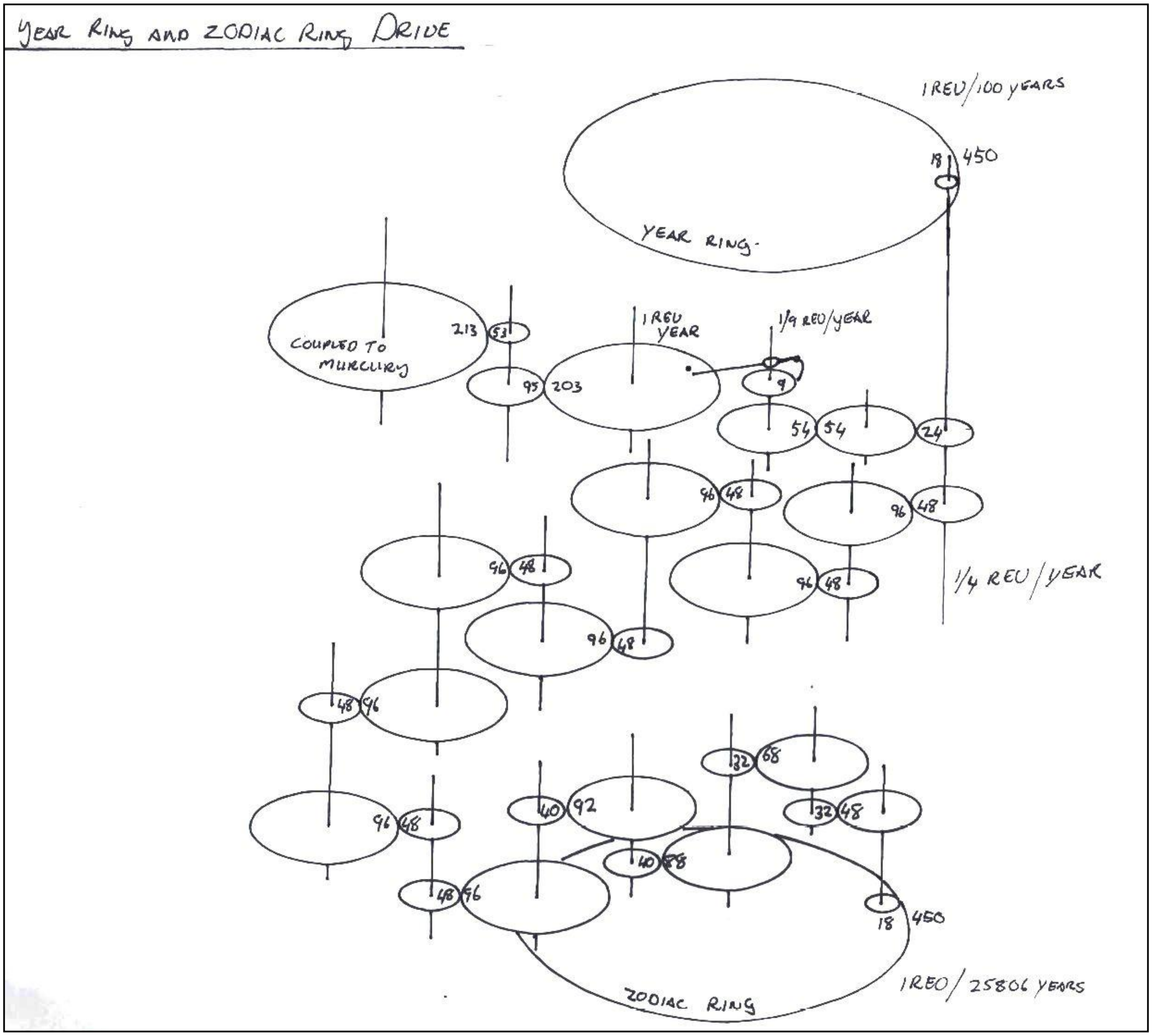
This drawing shows the revised drive for the zodiac precession as well as the year calendar ring being picked up from the planet Mars.



This drawing depicts the twelve wheels and twelve pinions Pouvillon had described in his newspaper interview in 1953 that would provide the 25,806 year rotation of the zodiac ring.



This drawing shows the mechanism to restore zodiac precession and year indication complications.



Appendix C.

In this section are two articles written up about the clock in French newspapers and their English translations.

1. Town of Nogent-sur-Oise newspaper, fourth quarter 2011 describing the clock and restoration project.

34 Nogent-sur-Oise Octobre - Novembre - Décembre 2011

8 octobre 2011 18 décembre 2011

En bref

L'horloge tourne...autour du monde

Un peu de Nogent s'exporte partout dans le monde. L'horloge Pouvillon a parcouru terres et mers et se trouve en ce moment dans les mains d'un collectionneur américain Mark Frank, qui a entrepris sa restauration. «L'horloge Pouvillon est l'une des plus complexes jamais fabriquées ! En tout cas la plus complexe pour sa taille. Je l'ai vue dans un livre il y a 30 ans et je me suis tout de suite dit que c'était la plus belle horloge que je n'avais jamais vue», explique avec passion Mark Frank. C'est une horloge planétaire qui délivre 57 indications: heure, saison, lever et coucher du soleil, mouvement des huit planètes les plus proches, les signes du zodiaque, la position des étoiles dans le ciel...

Le Nogentais Paul Pouvillon a mis plus de 25 ans pour mettre au point ce chef-d'œuvre de complexité, terminé à la fin des années 1930. «Il n'y a qu'une petite poignée d'horloges qui répond à ce design. L'horloge Pouvillon a été la première et la mieux réussie de toutes», poursuit l'Américain. Ce dernier a suspendu sa restauration car il est en attente de photos de l'horloge datant d'avant 1969. Il sollicite pour cela les Nogentais. «Nous pensons qu'il manque aujourd'hui deux spécifications qui étaient présentes au moment où Paul Pouvillon a construit cette horloge. Mais nous ne pouvons pas en être certains sans avoir de photos de l'époque». Mark Frank propose d'ailleurs de suivre mois par mois l'évolution de la restauration de cette œuvre sur le site :

http://www.my-time-machines.net/pouvillon_restoration1.htm.

Si vous possédez des photos de l'horloge, vous pouvez les envoyer à Mark Frank
mfrank1@rcn.com

2. Reward advertisement for information on the clock. This is the print version in the town newspaper of Nogent-sur-Oise. The same ad appeared in the on-line version of the Paris newspaper in *Le Parisian*.

l'Oise matin

Le collectionneur américain et la fabuleuse horloge

Un Américain amoureux des horloges rares recherche des documents d'époque pour restaurer un bijou construit en 1930 à Nogent. Il remettra 500 € en échanges des meilleures photos.

NOGENT-SUR-OISE

Une récompense de 500 € à la clé. Mark Frank, un Américain passionné d'horlogerie lance un appel aux Nogentais et aux habitants des alentours afin de retrouver les clichés d'une pendule. Mais pas n'importe laquelle.

Il y a quelques années, ce collectionneur a investi dans une horloge construite dans les années 1930 par le Nogentais Paul Pouvillon, 1878-1969 *(voir encadré)*. Aujourd'hui, Mark Frank entreprend la restauration de l'objet. « C'est l'horloge mécanique la plus compliquée au monde, s'enthousiasme Mark Frank, seule survivante de la collection de Paul Pouvillon, ce chef-d'œuvre a traversé les mers : vendue aux enchères à Londres par Christie's, elle est célèbre aux Etats-Unis et aujourd'hui en cours de restauration… en Australie ! »

« Elle est célèbre aux Etats-Unis et aujourd'hui en cours de restauration… en Australie ! »

MARK FRANK, AMÉRICAIN PASSIONNÉ D'HORLOGERIE

Pour venir à bout de la restauration de l'œuvre, Mark Frank s'est donc mis en quête de toute information, texte ou photo, touchant à l'objet, qui pourrait l'inspirer et l'aider à comprendre son mécanisme pour parvenir à une restauration parfaite. Il assure qu'il remettra 500 € pour les meilleures photos d'époque de la pendule astronomique. Car ses recherches se sont heurtées à un obstacle de taille, comme il le raconte : « L'atelier de Paul Pouvillon et sa maison, au 48, rue du Général-de-Gaulle à Nogent-sur-Oise, ont été achetés par la ville et rasés en 1970 », regrette l'Américain. Le collectionneur féru de beaux mécanismes a lancé un site Internet qui retrace la restauration de l'horloge en temps réel. Il invite désormais toute personne qui aurait connu, de près ou de loin, Paul Pouvillon et son œuvre à le contacter par mail*.

ELISA PERRIGUEUR

* Coordonnées : http://www.my-time-machines.net/pouvillon_restoration9.htm ou écrire à mfrank1@rcn.com.

REPÈRES

- **1878.** Naissance de Paul Pouvillon à Nogent-sur-Oise.
- **1895.** A 17 ans, il termine son tour de France des Compagnons et revient s'installer à Nogent.
- **1930.** Il réalise son chef-d'œuvre, une horloge planétaire qui donne 57 indications d'une précision remarquable : rotation du soleil, mouvements de la Lune, des huit planètes les plus proches, les signes du zodiaque, la position des étoiles dans le ciel.
- **1939.** Son œuvre est exposée au musée de Beauvais.
- **1948.** Paul Pouvillon est décoré de la Légion d'honneur.
- **1969.** Il décède à Nogent.

Heure, mois, saison, zodiaque, lever et coucher du Soleil : l'horloge de Paul Pouvillon donne 57 indications. Commencée en 1930 et complétée en 1939, c'est un chef-d'œuvre de mécanique et de précision (détails en médaillons). (DR.)

Translation of the Nogent-Sur-Oise article of the fourth quarter of 2011.

A little Nogent exports worldwide. The clock Pouvillon traveled land and sea and is now in the hands of a collector American, Mark Frank, who began its restoration."The clock Pouvillon is one of the most complex ever made! In any case, the morst complex for its size. I saw in a book 30 years ago and I am right immediately said that it was the most beautiful clock that I had ever seen," says Mark Frank with passion. This is a clock that delivers 57 global data: time, season, sunrise and sunset, the eight movement closest planets, zodiac signs, the position of the stars in the sky ...The Nogentais Pouvillon Paul had over 25 years developed this masterpiece of complexity over in the late 1930s. "There is a small handful clock that responds to this design. The clock has Pouvillon was the first and most successful of all," says the American. The latter has suspended its restoration as he is waiting for photos from before the clock 1969. He asks information of the Nogentais. "We believe it currently lacks two specifications that were present when Paul built this Pouvillon clock. But we cannot be certain without photos of the time. "Mark Frank offers month by month to follow the evolution of restoration work on this site: http://www.my-time-machines.net/pouvillon_restoration1.htm.

Translation of the reward solicitation in the Nogent-sur-Oise and Le Parisien newspapers, December 10, 2011.

English Spanish Arabic

A reward of € 500 to the key. Mark Frank, an American watch passionate appeal to Nogentais and nearby residents to find the pictures of a clock. But not any. A few years ago, this collector has invested in a clock built in the 1930s by Paul Nogentais Pouvillon 0.1878 to 1969. Today, Mark Frank undertook the restoration of the object. "This is the most complicated mechanical clock in the world, enthusiasm Mark Frank, the only survivor from the collection of Paul Pouvillon, this masterpiece has crossed seas auctioned by Christie's in London, it is famous in the United States and now being restored ... in Australia! "To come to the end of the restoration work, Mark Frank is set out in search of any information, text or picture related to the object, which could inspire and help understand its mechanism achieve a perfect restoration. He says he will deliver € 500 for the best vintage photos of the astronomical clock. For his research has run into a hurdle, as he said: "The workshop Pouvillon Paul and his house at 48, rue du Général de Gaulle in Nogent-sur-Oise, were purchased by the city and razed in 1970, "laments the American. The keen collector of fine mechanisms has launched a website that traces the restoration of the real time clock. He now invites anyone who may have known, near or far, Paul and his work Pouvillon to contact by mail *. * Contact: http://www.my-time-machines.net/pouvillon_restoration9.htm or write mfrank1@rcn.com.